SCIENCE ABSTRACTS.

PHYSICS AND ELECTRICAL ENGINEERING.

JANUARY 1899.

GENERAL PHYSICS.

1. *Length-Variation of Iron and Steel during Recalescence.* **G. E. Svedelius.** (Phil. Mag. 46. pp. 173–192, 1898.)—Summarised from the original Swedish, published in 1895. Bars of iron or steel 4 cm. long were placed between two jaws of porcelain, so arranged that their movements could be observed by means of a mirror and telescope. In this position the bars were heated up to 800°, and the change of length recorded as a function of the time photographically. At the same time the temperature was recorded by means of a thermocouple. A number of the photographs obtained are reproduced in the paper, and tables calculated from them given. The phenomena of recalescence observed confirm the observations of Barrett and Osmond, and anomalous changes of length were discovered which are closely associated with recalescence, but are too complex to admit of a useful abstract. The measurements were made on two kinds of iron, hardened and unhardened, and containing up to 1 per cent. carbon. R. A. L.

2. *Correction of Micrometers by Interference.* **M. Hamy.** (Comptes Rendus, 126. pp. 1772–1775, 1898.)—Describes a method of correcting micrometers by means of observations upon Newton's rings. The mean value of a turn of the screw expressed in red fringes may be obtained: on calculating the other intervals in terms of this mean turn of the screw, and comparing with the numbers found directly, the corrections of the screw are got, and it is easy to express these in seconds of arc. J. J. S.

3. *Interference Measurement Apparatus.* **C. Pulfrich.** (Zeitschr. Instrumentenk. 18. pp. 261–267, 1898.)—A description is given of an apparatus which has resulted from an endeavour to modify the Abbe-Fizeau dilatometer so as to extend its use in various ways. J. J. S.

4. *Maintenance of Pendulum Motion.* **G. Lippmann.** (Comptes Rendus, 127. pp. 15–18, 1898.)—When the motion of a pendulum is maintained by clockwork the duration of the oscillations is altered. All perturbation disappears if the motion is maintained by a series of instantaneous impulses, equal and alternately of opposite sign, impressed on the pendulum successively whilst ascending and descending. The pendulum may have any position at the moment of the impulsion, provided that it be the same for two successive impulsions. In this case these impulsions produce perturbations equal and of contrary sign whose sum is rigorously zero. It is good to produce the impulsions at the moment of passing through the position of equilibrium, the perturbations produced by each impulsion are then separately nothing, or infinitely small, and on alternating their signs their algebraic sum is made zero. The author discusses the principle of the method and its application to the maintenance of the geodesical pendulum. He also suggests that it might be applied in experiments for determining the mass of the earth. J. J. S.

5. *Maintenance of Pendulum Motion.* **A. Guillet.** (Comptes Rendus, 127. pp. 94–97, 1898.)—The author satisfies Lippmann's conditions for the maintenance of a pendulum without perturbation (See previous Abstract) by producing the impulsions by means of induction currents due to the closing and opening of an inducing circuit. The pendulum opens and closes the inducing circuit when it passes through the vertical in the two senses. The mechanism of the arrangement is described in the paper. The induction method reduces to a minimum the auxiliary mechanical appliances, which are always liable to get out of order; and the satisfactory working has been shown by a performance of four months constantly controlled. The equality of the periods of the free and maintained pendulum has been experimentally proved. J. J. S.

6. *Oscillations of Balances.* **D. Mendeleeff.** (Roy. Soc. Proc. 63. pp. 454–459, 1898.)—The observations were made with balances by Ruprecht and Nemetz of Vienna, belonging to the Central Chamber of Weights and Measures at St. Petersburg.

Calling the difference between the amplitudes of two consecutive oscillations the decrement, it is found that the time of an oscillation and the decrement decrease with the amplitude, whilst an increase of load sometimes increases sometimes diminishes them. Both the time of an oscillation and the decrement are diminished by increasing the sensibility, they are considerably affected by friction at the knife edges, and to some extent by the horizontal cross-section of the load. T. E.

7. *Disintegration of Incandescent Wires.* **W. Stewart.** (Wied. Annalen, 66. 1. pp. 88–91, 1898.)—The author has determined the disintegration of a glowing platinum or palladium wire in various media and under various pressures. He found that as disintegration goes on the rate of disintegration gradually decreases. It remains unaffected by the presence or absence of moisture, and by surrounding it with a brass tube connected to earth. As exhaustion is carried further, the disintegration of platinum diminishes, while that of palladium increases. In hydrogen, platinum is not disintegrated, even at a white heat, and palladium much less than in air at all events. In nitrogen the disintegration is very feeble. It is possible that the process of disintegration requires the presence of both oxygen and nitrogen. E. E. F.

8. *Air Jets.* **L. Mach.** (Wien Akad. Sitzber. 106. pp. 1025–1074, 1897.)—The author studies the structure of jets of air issuing from an orifice under various pressures by the interference method and by the method of striæ. The chief phenomenon noticed is that the jet appears broken up longitudinally into a series of double cones with their apices touching each other. These are due to a set of waves analogous to the head waves of projectiles, produced at the orifice just as if the latter were part of a projectile in motion. These head waves are reflected along the jet as they would along a tube, the motion of the jet through the neighbouring air being too rapid to allow the waves to penetrate the "skin" of the jet. The higher the pressure, the more pronounced is the occurrence of stationary longitudinal compression waves along the jet. These are not yet explained by theory. E. E. F.

9. *Air Waves due to Projectiles.* **Obermayer.** (Abstract in Engineering, 66. pp. 191–195, 1898.)—A number of new photographs of flying bullets, obtained by the method of striæ, are reproduced. Nearly all show the hyperbolic head wave which indicates that the velocity of the bullet is greater than that of

sound. But they also show the persistence of the air cushion in front of the bullet, which accounts for its apparent explosive effect. E. E. F.

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10. *Spreading of Liquid Films.* **J. Stark.** (Wied. Annalen, 65. 2. pp. 287–305, 1898.)—A number of experiments are described illustrating the spreading of a liquid at the surface of two media, where the capillary tension of the surface between the latter is greater than the sum of those at the surface of the liquid and the two media. Soot particles are used to render the movement visible, and the separation of these at the surfaces against which the movement carries them, and the convective motion in the media, are described and explained. B. B. T.

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11. *Elasticity of Thick Masses.* **Ribière.** (Comptes Rendus, 126. pp. 1190–1192, 1898.)—A discussion is given of the resistance to mechanical forces exhibited by thick blocks or masses, such as walls, &c. J. J. S.

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12. *Fizeau's Researches.* **A. Cornu.** (Annuaire du Bureau des Longitudes, 1898, pp. C. 1–C. 40.)—An interesting *résumé* of Fizeau's optical and metrological work. A. D.

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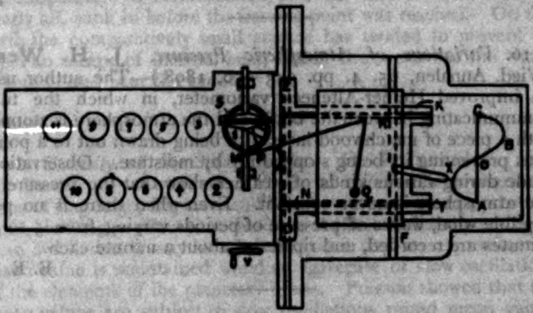
13. *Harmonic Analyser.* **J. N. Le Conte.** (Phys. Rev. 7. pp. 27–34, 1898.)—A harmonic analyser with eleven elements has been constructed at the University of California on the same fundamental principle as that of G. U. Yule's instrument made in 1895, the only difference being in the relative motion of the parts. The eleven axles (fig. 1) are connected by gearing in such a way that while the first revolves once, the second revolves twice, the third three times, and so on. Upon each axle is mounted a graduated circle, which may be turned through any epoch angle and clamped in any position. Across a diameter of each circle is a sliding bar, carrying a cylindrical pin, *s*, whose distance from the centre is adjusted by means of a graduated scale. Each pin works in the groove of a slotted cross-head, to which it communicates a simple harmonic motion when the whole is driven by the hand-wheel, *V*. *DK* is a flat platform of brass sliding along a pair of guides parallel to the direction of the harmonic motion of the cross-heads. Motion is communicated to it by a rack, so that while axle 1 rotates once, the platform moves through a distance 2π inches. Upon the upper face of

this platform is another pair of rectilinear guides, *LK* and *NT*, and upon these a light carriage runs on grooved wheels carrying a small planimeter board. The curve to be analysed is placed upon the base of the machine, and a point, *X*, attached to the carriage can be caused to trace round its perimeter. The accuracy of the instrument is said to be as great as that of most of the recent analysers. The instrument can also be used for drawing the curve whose coefficients are given up to the eleventh term, though no great accuracy is claimed for this process. When the instrument is arranged as a curve tracer, a grooved pulley is mounted upon each cross-head and a brass wire is passed around them all. The free end is attached to a light pen carrier, which slides on a pair of tense wires at right angles to *DE*. A small weight takes up the slack of the wire, and the drawing paper is fastened to the platform *DK*. Amplitudes are set off on the sliding bars of the elements, and epoch angles on the graduated circles. A. S.



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14. *Optical Curve Tracer.* **J. A. Switzer.** (Phys. Rev. 7. pp. 83–92, 1898.)—The paper contains an account of the attempts made by the author to adapt the ingenious arrangement used by A. C. Crehore (see Phys. Soc. Abstracts, No. 652, 1895) for the measurement of the velocity of projectiles to the recording of alternating current curves. Briefly, the apparatus consists of a tube filled with carbon bi-sulphide, and surrounded by a coil conveying the current to be recorded. The light passing into the tube is polarised by a Nicol prism, and on emerging from the tube passes through a plate of quartz, a collimator, another Nicol prism, a dispersing prism, photographic lens and plate, the latter being allowed to fall by gravity when a record is taken. The function of the quartz plate is to produce an initial rotation of the plane of polarisation, and thus furnish a dark band in the

spectrum even when no current passes through the coil. Reproductions of photographic records obtained in this way accompany the paper. These are very poor, and seem to justify the author in his conclusion that the method is not likely to find any practical application. A. H.

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15. *Value of Gravity near Etna.* **A. Riccò.** (Roma R. Accad. Lincei Atti, 7. 2. pp. 3–14, 1898.)—The author, employing Sterneck's pendulum, determines the value of g at various points near Etna, and makes surmises with regard to the distribution of matter underground thereabouts. A. Gs.

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16. *Variations of Atmospheric Pressure.* **J. H. West.** (Wied. Annalen, 65. 4. pp. 943–950, 1898.)—The author uses an improved Hefner-Alteneck variometer, in which the tube communicating between the bottle and the atmosphere is stopped with a piece of matchwood instead of being drawn out to a point, thus preventing its being stopped up by moisture. Observations made during various kinds of weather show that the pressure of the atmosphere is never constant. Even when there is no perceptible wind, waves of pressure of periods varying from 5 to 30 minutes are recorded, and ripples of about a minute each.

E. E. F.

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17. *Photography of the Lunar Surface.* **Loewy** and **Puiseux.** (Ann. du Bureau des Longitudes, 1898, pp. A. 1–A. 36.) The authors first discuss the advantages of photographic as contrasted with ocular methods, and the difficulties inherent in photographic methods as applied to the lunar surface, arising from the necessity of giving a comparatively long exposure when fine detail is required in the image of a moving body; the air is also so far from uniform that during four years only ten nights have at Paris been found suited to lunar photographic work. The authors then proceed to discuss the problems to be solved, and the light thrown upon them by those good negatives which have actually been secured. An account is given of the changes which are supposed to have occurred on the moon's surface since detail markings were first studied; and the conclusion is reached that no change has occurred during the last half century such as causes any permanent modification of the general aspect of the moon, and that it is safer to ignore the past, as regards minor details, and start with the recent negatives, which show clearly the general grooving of the surface and the slight differences in colour between different portions of the surface. They also show, from the way the volcanic *débris* lies, that there must at one time have been a much denser atmosphere than

corresponds with the theoretical distribution of atmosphere between the earth and the moon, which would give the moon about $\frac{1}{728}$ of the whole. Probably the hydrogen was early lost, the other gases have been absorbed in chemical combination, and the water has sunk into the interior, to an extent no longer limited by internal heat as it is in the case of the earth. At present there is no surface liquid and no appreciable atmosphere, and there is no apparent trace of surface erosion by water. The surface also is that of bare rock, and there is no coating of ice in sight, not even at the poles, though it is not yet quite clear that there may not be some in the circumpolar depressions. The water vapour must have become rare before the surface cooled down to the temperature of condensation, and the water must have all, or nearly all, sunk in before the freezing-point was reached. On the earth the comparatively small surface has tended to prevent so rapid an escape of internal heat, and in the meantime the water is kept at and near the surface. A. D.

18. *Stability of the Solar System.* **H. Poincaré.** (Ann. du Bureau des Longitudes, 1898, p. B16.)—The demonstrations of Lagrange, Laplace, and others, are successive approximations, showing in effect that the integral effect of disturbing causes is so small that it may be neglected, and that an approximately mean value is maintained amid an aggregate of slow oscillations of the elements of the planetary orbits. Poisson showed that the mean values are subject to slow oscillations round mean values which are still more approximately constant. Delaunay, Tisserand, and Gylden have shown that practically the same result follows in the case of commensurable mean motions. The result is that stability for a long time is proved, but not stability for ever. The demonstrations assume, however, that the planets are material points subject only to Newton's law of gravitation. But there are complementary forces, greater in their effect than the terms neglected in the demonstrations referred to. The law of the inverse squares need only be approximately valid in order to ensure the maintenance of stability. The entropy of the system, on the other hand, tends always to diminish, and does so upon the occurrence of each and every irreversible phenomenon, such as friction between the planets and the interstellar ether, or the pull-back by the tides upon the heavenly bodies whose motion gives rise to them, and whose kinetic energy is partly taken up in producing heat in the tidal water (Delaunay and G. Darwin) through friction retarding the tidal wave, introducing asymmetry and retarding the earth's rotation. We seem to have an instance of the effect of tidal action in the equality of the periods of rotation and of revolution of the moon. In the absence of any interstellar medium producing friction the ultimate effect of the tides would be to make the whole solar system rotate like a solid

body; but ether-friction would bring the planets gradually towards the sun. Even solid globes would show the same tidal effect in less degree, and the same end would be reached. The heavenly bodies if magnetic and conductors, like the earth, would also tend to slow down each other's relative motion; and even a frictionless vacuum would not prevent the same end being reached in time. A. D.

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19. *Solar Radiation.* **J. Janssen.** (Ann. du Bureau des Longitudes, 1898, pp. D. 1–D. 4.)—On Mont Blanc the solar constant was determined at between 3·23 and 3·26, but on specially clear days it was found to be 3·4, with some portions of curves giving 3·9. The value 3·4 is in the meantime that announced. A. D.

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20. *Magnetic Reproduction of Orbital Motion.* **R. W. Wood.** (Phys. Rev. 7. pp. 119–121, 1898.)—This note treats of a lecture experiment in which a steel bicycle ball rolls in a quasi-orbital manner on a glass plate under the influence of an electro-magnet below, whose pole-piece pierces the plate. The author has previously published this method, and now defends it against the criticism that the ball would be subject to an attractive force following the law of the inverse fifth power of the distance instead of the inverse square. The author points out that his critics have overlooked the fact that the ball is urged towards the centre by the horizontal component only of the attraction, and he finds that by suitably choosing the height of the plate above the pole-piece a position may be obtained for which within certain limits of distance the law is that of the inverse square. Several descriptions of an elliptical spiral may thus be realised and exhibited to an audience. E. H. B.

LIGHT.

21. *Infra-Red Absorption.* **H. Rubens and E. Aschkinass.** (Wied. Annalen, 64. 3. pp. 584–601, 1898.)—According to Langley, the infra-red solar spectrum terminates at 5 μ, the region beyond being absorbed by the atmospheric carbonic acid and water vapour. Since Rubens and Nicholls proved that beyond 24·4 μ a considerable amount of radiation is transmitted again by those gases, the authors sought these rays in the solar spectrum by their method of successive reflections. The result was negative, and further experiments proved that carbonic acid and water vapour do absorb those rays when present in layers of sufficient thickness. The atmosphere is perfectly opaque for rays from 12 to 20 μ and 24·4 μ. Langley's observations only extended to 11 μ. For meteorology this result is of slight importance, since the solar radiant energy beyond 12 μ is very small compared with the total energy. E. E. F.

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22. *Optical Properties of Hydrophane.* **J. Stscheglayew.** (Wied. Annalen, 65. 4. p. 745, 1898.)—The author acknowledges Christiansen's priority as regards his determination of the refraction index of hydrophane. (See 1898, Abstract No. 748.)
E. E. F.

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23. *Rotatory Power of Quartz in the Infra-Red.* **R. Dongier.** (Comptes Rendus, 126. pp. 1627–1628, 1898.)—The author modifies the values he formerly gave (C. R. 125. p. 228), the wave-length of the radiations which he used having been calculated from M. Carvallo's results on the dispersion of quartz; these have now been more accurately obtained by M. Carvallo (C. R. 126. pp. 728–731; see 1898, Abstract No. 1120), hence the alteration of the author's numbers. J. J. S.

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24. *Fringes of High Order.* **C. Fabry and A. Perot.** (Comptes Rendus, 126. pp. 1561–1564, 1898.)—The authors have already made use of the fringes produced between two plane and parallel surfaces of silvered glass, illuminated by a beam of monochromatic light, for the study of the constitution of many rays of the spectrum. These fringes observed by transmission by means of a telescope have the aspect of concentric circles whose diameters follow the same law as those of Newton's rings. To a point of the field corresponds a definite incidence *i*,

and for that point the retardation which produces the interference is $\Delta = 2\,e \cos i$ (e being the distance between the two silvered planes). The fractional part of the quotient $p = \frac{\Delta}{\lambda} = 2\,e \cos i/\lambda$ is the difference of phase for the radiation λ, and the value of p is simply the retardation expressed in wave-lengths λ; each integral value of this quantity characterises a brilliant fringe of which it is the number of order. When the distance between the silvered surfaces is somewhat great, the number of order of the rings observed becomes very high ($p = 160{,}000$ for $e = 4$ cm. and $\lambda = 0{\cdot}5\,\mu$); the method employed for determining this number depends on the employment of many monochromatic radiations suitably chosen, of which the wave-lengths are in ratios exactly known. Suppose the apparatus is illuminated by two simple radiations, the one red and the other green, for example, of wave-lengths λ and λ' ($\lambda > \lambda'$). The rings due to these radiations will fall near each other without blending, on account of the presence of the brilliant fringes, and the rings of the two systems can be distinguished by their colours. If the distance between the silvered surfaces be caused to vary, these two systems contract or dilate simultaneously without the occurrence of movement of one system relatively to the other. A red ring of definite order will be always accompanied in the same manner by the same red and green rings which surround it. The fashion in which these rings present themselves will be characteristic of the red ring considered, and can serve as a means of its recognition. J. J. S.

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25. *Numbers of Order of Fringes.* **A. Perot and C. Fabry.** (Comptes Rendus, 126. pp. 1624–1626, 1898.)—The authors give a further account of the determination of the numbers of order of fringes, the principle of the method being based on the employment of a certain number of simple radiations suitably grouped two and two. (See previous Abstract.) They use for those measurements the red and green radiations of cadmium, employed by Michelson, and the yellow and green radiations of mercury. J. J. S.

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26. *Flicker Photometer.* **O. N. Rood.** (Science, 7. pp. 757–759, 1898.)—A description is given of a photometric method founded on flickers. The two sides of a white upright 90° prism are illuminated with the lights to be compared, and the flicker is brought about by the rapid motion of a cylindrical lens, or biprism of small angle placed opposite the angle of the white prism. The lens is caused to oscillate horizontally by a train of toothed wheels, turned by hand or by a small electromotor. By this means the two illuminated sides of the prism are presented

rapidly in succession to the eye placed beyond an aperture in front of the lens. Results of considerable accuracy were got even by persons unused to photometric work. J. J. S.

27. *Colour-Blindness and the Flicker Photometer.* **O. N. Rood.** (Science, 7. pp. 785–786, 1898.)—The author describes the application of the flicker photometer to obtain a measurement of the relative extents of colour-blindness. J. J. S.

28. *Flicker Photometer.* **F. P. Whitman.** (Science, 8. pp. 11–13, 1898.)—The author describes his experience with flicker photometers and corroborates Rood's statement (see 1899, Abstract No. 26) as to the ease with which the flicker photometer is handled by observers unaccustomed to its use. J. J. S.

29. *New Photometric Standard.* **C. Fery.** (Comptes Rendus, 126. pp. 1192–1194, 1898.)—The author uses as a standard of light acetylene burning in free air at the extremity of a thermometer tube whose diameter is 0·5 mm. The intensity is proportional to the height of the flame, between 1 cm. and 2·5 cm. J. J. S.

30. *Joly Colour-Photography Process.* **J. S. Gibson.** (Eng. News, 39. pp. 298–299, 1898.)—The Joly process is based on the fact that the eye is unable to differentiate colours lying within a certain area, termed by the author the "Retinal unit," and which does not exceed two or three minutes of arc. Consequently if the three primary components of a primary colour are placed side by side within the limits of this retinal unit, the area appears as of the composite colour. The process therefore differs in principle from Ives' in that the synthesis is effected by juxta- instead of super-position. The practical working is as follows: The light before falling on the photographic plate passes through a "taking screen." This is a gelatine-coated glass plate, ruled with tricolour bands (orange-red, yellowish-green, and blue), each colour-line being 1/225 in. broad. The light passing through this is split up into its three components arranged side by side in a space of 1/75 in., and the resulting negative consists of bands of silver deposit proportional in density to the intensity of the components of the colours. From this a positive is taken, in which the densities are reversed; on this is placed a "viewing screen" similar to the "taking screen" except that the colours are red, green, and violet. This, if correspondingly superposed, provides the component colours, which are regulated in intensity

by the density of the positive plate and are synthesised by the eye. The breadth of tricolour band required for perfect synthesis is about 1/400 in. at the ordinary range of vision, but 1/75 in. is found sufficiently narrow in practice. Exposure must be made through an orthochromatic screen (picric acid stain) on orthochromatic plates to obtain photographic equality in the colours. G. H. Ba.

31. *Coloured Photographs.* **L. Delvalez.** (Comptes Rendus, 127. pp. 207–208, 1898.)—A description is given of a method by which the author claims to get coloured photographs through the unequal lighting up of a brass plate placed as an extra electrode in an electrolytic bath containing a mixture of the acetates of copper and lead. J. J. S.

32. *The Zeeman Phenomenon.* **H. Becquerel** and **H. Deslandres.** (Comptes Rendus, 126. pp. 997–1001, 1898.)—An account is given of the anomalous behaviour of certain rays, especially in the spectrum of iron, with respect to the Zeeman effect. Some rays are not doubled in the magnetic field, others become doublets, triplets, or quadruplets; the effects differing in the case of polarisation perpendicular to the field and polarisation parallel to the field. The anomalies show that the magnetic influence makes evident differences heretofore unknown between the rays of the same spectrum. J. J. S.

33. *Zeeman Phenomenon.* **H. Becquerel** and **H. Deslandres.** (Comptes Rendus, 127. pp. 18–24, 1898.)—After describing their new experiments on the behaviour of different rays (especially those of iron) in very strong magnetic fields—up to 35,000 c.g.s. units—and arranging the various rays in classes according to their mode of division under the influence of the field, the authors seek for some general law of the doublings. They find that the doublings observed in the ultraviolet region are on the average notably smaller than those of the blue region. The phenomenon appears connected with a function of the wave-length which increases with that variable. If a region very limited and rich in rays be examined, anomalies and doublings the most diverse are met with there in the immediate neighbourhood of radiations insensible to the magnetic influence; classing the doublings in function of the wave-lengths of the corresponding rays, for the most part they may be ranged in different categories such that for rays of neighbouring wavelengths the doublings are amongst themselves as the numbers 1, 2, 3, 4 . . . , and in the same category the doublings are

almost proportional to the square of the wave-length. The fact is specially noticeable for the greatest series of doublings, so that the modification that each ray of this series experiences due to the magnetic field would correspond to the same variation in the number of luminous vibrations emitted during the same time. For the rays which divide into fine bands the doublings of the radiations vibrating parallel or perpendicular to the field, are for the same ray exactly in the ratios of 1, 2, 3, 4 . . . The distribution of the doublings in the spectrum in function of the wave-length appears besides to affect a sort of periodicity. J. J. S.

34. *Secondary Radiation.* **G. Sagnac.** (Comptes Rendus, 127. pp. 46–49, 1898.)—Further discussion showing that the "metal effect" is quite accounted for by the author's secondary rays (see 1898, Abstracts Nos. 245, 491, 765, and 1131). A. D.

35. *New Radio-Active Element in Pitch Blende.* **P. Curie** and **Mme. Sklodowska-Curie.** (Comptes Rendus, 127. pp. 175–178, 1898.)—The suggestion that pitch blende contains some substance more active than uranium (see 1898, Abstract No. 1224) has been followed up and found to be true. It is present in the sulphides precipitated by sulphuretted hydrogen from an acid solution of pitch blende, and is so in company with lead, bismuth, copper, arsenic, and antimony. Sulphide of ammonium removes the arsenic and the antimony, nitric acid dissolves the remaining sulphides, and sulphuric acid removes the lead; the sulphate of lead should be well washed with dilute sulphuric acid in order to recover the portion of the element sought for, which is carried down by the precipitate. There remains in solution the new element, with bismuth and copper: ammonia in excess precipitates the two former. No good method has been found for completely separating these by wet methods, but the two sulphides have different volatilities, and when sublimed in a vacuum tube condense at different parts of the tube. The ultimate product is a sulphide 400 times as active as uranium, and appears to be that of a new metal, analytically related to bismuth: name proposed, Polonium. There is, however, no characteristic ray in its spectrum; but this is the character of the spectra of uranium, thorium, and tantalum, which present merely innumerable very fine lines, difficult to recognise. A. D.

36. *Conversion of Kathode Rays into Light.* **E. Wiedemann.** (Wied. Annalen, 66. 1. pp. 61–64, 1898.)—The alleged economy of luminescent or fluorescent sources of light is based upon the

fact that the maximum energy radiated by them lies in the visible spectrum, the infra-red rays being practically absent. But when the expenditure of energy necessary to produce this glow is considered, the economy is very small. The author determined the heating effect which accompanies luminescence by inserting a calorimeter vessel in a vacuum tube, leaving it open at the top, and painting its bulb with Balmain's luminous paint or with Sidot's blende. He found that only about 5 or 7 per cent. of the incident energy was converted into light, that being about the same ratio as in the incandescent lamp.

E. E. F.

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37. *Röntgen and Kathode Rays.* **J. von Geitler.** (Wied. Annalen, 66. 1. pp. 65–73, 1898.)—The author quotes a number of experiments to show that Röntgen rays are absolutely incapable of conveying a charge. They can equalise opposite charges, by rendering the air between them conducting, but they cannot, like kathode rays, convey an electric charge into the interior of a closed metallic vessel connected to earth, or out of such a vessel into the open air. E. E. F.

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38. *Corpusculai Theory of Röntgen Rays.* **B. Walter.** (Wied. Annalen, 66. 1. pp. 74–82, 1898.)—Instead of regarding Röntgen rays as intermittent waves, they may be regarded as discharged kathode particles. Then the absence of magnetic deflection would follow as a matter of course. They penetrate the walls of a tube with greater ease than kathode rays on account of the absence of electric charge. They are undoubtedly much smaller than the electro-chemical ions. That their absorption should vary as the density of the absorbent is easily understood. Their power of ionising gases must be attributed to the destruction caused by their impact upon gaseous molecules.

E. E. F.

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39. *Glow-Discharge Spectra.* **A. Kalähne.** (Wied. Annalen, 65. 4. pp. 815–848, 1898.)—Using a battery of 600 cells, the author examined the continuous-current glow spectra of mercury, zinc, cadmium, sodium, and other vapours. He found that all these metals, like the metalloids, yield band spectra of inferior orders. Such band spectra may also be produced with the aid of an induction-coil, but in that case the band spectrum is faint in comparison with the line spectrum, the former being characteristic of lower temperatures. The correspondence between radiation and current strength, observed by Ångström in the case of nitrogen and hydrogen, does not apply to cadmium or mercury vapour. In the case of cadmium the intensity of the lines increases more rapidly, and in the case of mercury less rapidly than the current strength. E. E. F.

40. *Luminosity of Spectra of Gases.* **E. S. Ferry.** (Phys. Rev. 7. pp. 1–9, 1898.)—I. With gas pressure of from 0·25 mm. to 4·00 mm. of mercury, and current strengths from 1 milliampere to 6 milliamperes, the luminosity of the separate spectral lines of gases at a given pressure is directly proportional to the current strength. II. With constant current, the luminosity of a spectral line of a gas increases as the pressure decreases, at first slowly and then more rapidly. The curve showing the relation between the pressure of the gas and the luminosity of a spectral line is regular, but is different for different lines. G. B. M.

41. *Radiation from Incandescent Gas Mantles.* **H. Le Chatelier and O. Boudouard.** (Comptes Rendus, 126. pp. 1861–1864, 1898.)—Luminescence is unnecessary as a means of explanation of the luminosity, and does not meet the case. The phenomenon is one of high temperature due to the material of the mantle being a bad radiator until a certain high temperature is attained. Heat therefore accumulates in the mantle until this temperature is reached. The effect depends only on the temperature attained, and not on the nature of the surrounding gases; this displaces Bunte's theory that catalytic action is the cause of the high temperature. The actual temperature is about 1650°. The proportion of radiation emitted in the form of light is very large; but the absolute amount of radiation in the form of light is less than it would be from a black substance at the same temperature. The difference is that the black substance under the same conditions would, through premature radiation, not reach the same temperature, and would therefore emit comparatively little light. A. D.

HEAT.

42. *Specific Heats of the Elements.* **W. A. Tilden.** (Chem. News, 78. pp. 16–18, 1898.)—In order to decide whether the atomic heats of the elements are identical, the specific heats of three pairs of carefully purified metals of nearly the same atomic weights are determined. The following are the mean results:—

Metal.	Specific Heat.	Atomic Heat.	Metal.	Specific Heat.	Atomic Heat.
Cobalt	0·10348		Nickel	0·10931	
Gold	0·03035	5·94	Platinum	0·03147	6·05
Copper	0·09232	5·83	Iron............	0·11030	6·13

The atomic weights of cobalt and nickel being practically identical, their specific heats should be so likewise. The author suggests that the cause of the difference is to be sought in peculiarities in the configuration of the atoms of the metals.

T. E.

43. *Specific Heat of Gases.* **S. Lussana.** (N. Cimento, 7. pp. 61–62, and 365–376, 1898.)—(i.) Experiments made by Lussana tend to confirm Amagat's law, according to which "the specific heat at constant pressure, referred to unit mass, of carbonic anhydride increases rapidly with the pressure, reaches a maximum at about 110 atmospheres and then diminishes, at any rate up to 150 atmospheres, the limit of pressure reached in the author's observations." This maximum tends to disappear with increase of temperature. In experimenting with mixtures of air and carbonic anhydride, it is found that, as the proportion of air is increased, the maximum observed in the carbonic anhydride for the values of C_p at about 110 atmospheres, tends to disappear and becomes non-existent when the proportion of air is sufficiently great. Experiments on acetylene had to be discontinued on account of its explosive character. (ii.) In the second paper new experiments relating to air are described, the methods of determining C_p at various pressures being radically changed. The first series of experiments shows that the mean variation of C_p per atmosphere is about 0·00111; the second to confirm the empirical formula $C_p = 0{\cdot}23702 + 0{\cdot}0015504\,(p-1) - 0{\cdot}0000019591\,(p-1)^2$. Comparing the results with those of Amagat and Witkowski, it is legitimate to infer that the specific heat of gases at constant pressure referred to unit mass increases with the pressure, attains

a maximum, and then decreases, that for air it is represented by the above formula, and that, moreover, it varies with the temperature. (For the previous paper see 1898, Abstract No. 129.)

G. H. Br.

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44. *Specific Heats of Gases.* **O. Lummer** and **E. Pringsheim.** (Wied. Annalen, 64. 3. pp. 555–583, 1898.)—This is a somewhat enlarged report of the experiments already described at the Oxford meeting of the British Association. The bolometer has been improved and the errors due to conduction of heat have been eliminated. The ratio of the two specific heats is for—

Air	1·4004
Oxygen	1·3977
Carbonic Acid	1·2995
Hydrogen	1·4084

E. E. F.

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45. *Latent Heat of Evaporation of Zinc and Cadmium.* **W. Sutherland.** (Phil. Mag. 46. pp. 345–346, 1898.)—Barus has given measurements of the vapour pressure curves for zinc and cadmium (Phil. Mag. (5) 29). From these the author calculates by means of the well-known thermodynamic equation that the molecular internal latent heats are 27,000 and 28,000 respectively for volatilisation of the solid metals under atmospheric pressure. Theoretical reasoning of his own gave 29,600 for each (Phil. Mag. (5) 40).

R. A. L.

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46. *Surfusion of Metals and Alloys.* **W. C. Roberts-Austen.** (Roy. Soc. Proc. 63. pp. 447–454, 1898.)—By means of the photographic recording thermo-element, the phenomenon of surfusion is shown to occur with gold, copper, bismuth, antimony, tin, and lead. Reproductions of several of the curves are given in the paper. Surfusion is also observed with alloys, but the curves are more complicated owing to the formation of super-saturated solutions. The alloys of tin and lead are fully studied from this point of view. It is suggested that the extreme instability of metals in a state of surfusion may be due to the introduction of crystalline nuclei from the metallic vapour given off. An appreciable quantity of vapour is evolved by metals even at low temperatures. Silver and cadmium placed at some distance apart in a vacuous tube at 50° yielded a coloured film of silver cadmium alloy on the silver after eight days.

T. E.

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47. *Influence of Pressure on Melting-Point.* **E. Mack.** (Comptes Rendus, 127. pp. 361–364, 1898.)—Certain organic

solids were melted in a dilatometer capable of standing pressures up to 2,140 atmospheres, provided with a piston manometer. Naphthalene was found to have a melting-point t under pressure p given by

$$t = 79{\cdot}8 + 0{\cdot}0373\,p - 0{\cdot}0000019\,p^2$$

while α-naphthylamine, diphenylamine, and paratoluidine gave still more nearly linera results. R. A. L.

48. *Measurement of Temperature.* (Mech. Eng. 2. pp. 149–151, 219–221, and 258–259, 1898.)—Articles dealing with the various methods of temperature measurements. EDITOR.

49. *Thermo-Electric Pyrometry.* **A. Stansfield.** (Phil. Mag. 46. pp. 59–82, 1898.)—The thermo-couples employed consist of a wire of platinum and another of platinum alloyed with 10 per cent. of Rhodium or Iridium; one junction being at 100° C. and the other at the temperature to be measured. The E.M.F. of the thermo-couple is recorded photographically by a method which combines the use of a potentiometer with the recording system of Roberts-Austen. Differences of temperature at 1000° C. can easily be measured in this way to 0.1° C., and the indications of the pyrometer do not change more than about 5° C. at temperatures of 1000° C. after a year's use.

The thermo-electric power of the couple composed of platinum and platinum alloyed with 10 per cent. of Iridium is a little greater than that of a thermo-couple containing 10 per cent. of Rhodium, but the *partial* substitution of Iridium for Rhodium in the latter couple very materially *reduces* the thermo-electric power.

The contact electromotive force $T\frac{dE}{dT}$ of these thermo-couples is approximately a linear function of the temperature. A table is given of the melting temperatures of certain metals as afforded by recent research. AUTHOR.

50. *Absolute Temperature.* **O. Wiedeburg.** (Wied. Annalen, 65. 4. pp. 921–922, 1898.)—The author points out, in accordance with his previous work, that the anomalous position of the theory of heat among the theories of other forms of energy is eliminated by regarding a "falling quantity of heat" as a quantity in the same sense as a falling quantity of water or electricity. E. E. F.

51. *Temperature of a Linear Conductor of Two Metals.* **P. Straneo.** (Roma R. Accad. Lincei Atti, 7. 2. pp. 346–353. 1898.)—The conductor consists of two bars of section q, and lengths l_1 l_2 taken for axis of x. It is traversed by a constant electric current i. The whole is initially at temperature zero, and the extremities are so maintained. Considering the Thomson and Peltier effects, and other known phenomena, the writer obtains differential equations which u_1 u_2, the temperatures of the two bars, have to satisfy. When the temperatures become stationary they are represented by U_1 U_2, and the differential equations then assume special forms for which integrals are obtained.

Finally, the special case is considered in which the greatest variations of temperature of the conductors are very small. In this case the differential equation assumes for the first bar the form—

$$U = \frac{i^2 \omega}{J q h p} + A_1 \epsilon^{\lambda x} + B_1 \epsilon^{-\lambda x}$$

where ω is the ohmic resistance, h the external conductivity for heat, and p the perimeter, k the internal conductivity, and $\lambda = \sqrt{\frac{hp}{kq}}$. A and B are constants to be found by the terminal conditions. A further communication is promised. S. H. B.

52. *Mechanical Equivalent of Heat.* **O. Reynolds** and **W. H. Moorby.** (Mem. Manchester Lit. & Phil. Soc. 42. 6. pp. 1–54, 1897–8.)—Water at 0° C. was forced at a steady rate through a vessel wherein it was churned so as to issue at 100° C., an internal stirrer being rotated by steam-power while the vessel was balanced by an external brake-dynamometer which measured the work absorbed. For details the paper must be referred to. The final result obtained is 776·94 in British gravitation-units at Manchester, which in C.G.S. absolute units gives 41,832,000, the heat-unit being the hundredth part of the heat required to raise 1 pound and 1 gramme respectively of water from 0° to 100° C. The method is due to the former of the authors, the experimental determination to the latter. R. E. B.

53. *New Electro-Thermal Relation.* **O. Wiedeburg.** (Wied. Annalen, 66. 1. pp. 92–110, 1898.)—When the metals are arranged in the order of their power of emitting radiant heat, the series corresponds with their electrical resistances, although the ratios are not the same. An exception occurs in the case of nickel, whose radiating power is too small. Alloys do not fit into the series, but conform to a series of their own. Bismuth

is the best radiator, and silver the worst. The emissivity of bismuth is closely approached by a copper-manganese alloy containing 30 per cent. of manganese. E. E. F.

54. *Bolometers.* **S. P. Langley.** (Amer. Journ. Sci. 5. pp. 241–245, 1898.)—The author describes the latest form of his bolometer, which is provided with a metal case kept at a constant temperature. It is also specially protected against earth tremors. As regards precision, or exactness of pointing, it can be set to within a second of circular arc in the dark. As regards accuracy, it is safe to say that no inaccuracy can be detected by comparing successive readings of a constant source. The apparatus is about 400 times as sensitive as when first described. It will indicate a change of temperature in its strips of much less than one-ten-millionth of one degree centigrade. E. E. F.

55. *Absolute Actinometer.* **A. Crova.** (Comptes Rendus, 126. pp. 1394–1398, 1898.)—A description is given of the author's standard actinometer in which differences of temperature are measured by a thermo-electric arrangement. J. J. S.

56. *Thermal and Electrical Conductivities of Iron and Copper.* **P. Straneo.** (Roma R. Accad. Lincei Atti, 7. 1. pp. 310–314, 1898.)—The changes in the thermal conductivities of copper and iron between 10° and 100° are small and cannot be determined with accuracy by the method employed, which is correct to only 1 per cent.

Simultaneous measurements of the electrical conductivities give the usual large increase with rise in temperature. A. Gs.

57. *Transmission of Heat through Plates.* **G. Haliday.** (Indus. and Iron, 24. pp. 487–488. and 25. pp. 4–6, 1898.)—A paper read before the Institution of Engineers and Shipbuilders in Scotland, giving the leading known facts on the subject. The paper is illustrated by numerous diagrams and tables. A. S.

58. *Propagation of Heat.* **G. Lauricella.** (Torino, R. Accad. Sci. Atti, 33. pp. 729–743, 1897–1898.) — This paper refers to a note by Stekloff (Comptes Rendus, April, 1898). Any arbitrary function which with its derivation of the first three orders is finite and continuous at all points within any body S, and which with its normal derivation is finite and continuous at all points on the bounding surface, can always be decomposed

into two functions, of which one represents the stationary temperature, which has no influence on the propagation of heat, and the other satisfies the limiting equations. Stekloff's demonstration of the existence of this latter function being not free from doubt, the following theorem is enunciated: "The variable temperature of a body initially given at any arbitrary temperature can always be regarded as the superposition on a stationary temperature of a finite or infinite number of elementary temperatures." S. H. B.

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59. *Theory of Liquids with Unassociated Molecules* (Part II.). **G. Bakker.** (Journ. de Physique, 7. pp. 511–515, 1898. Continued from vol. 6, p. 577, 1897; see 1898, Abstract No. 263.)—This paper, the reasoning of which does not well admit of an abstract, is a continuation of the author's previous speculations on molecular theory based chiefly on the virial theorem, and on certain assumptions of which the author admits the doubtfulness. His chief conclusion is that the virial of the molecular forces is equal to 3/2 the product of the internal pressure by the volume; and he arrives at an opinion in favour of the inverse fourth power law as to molecular forces. R. A. L.

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60. *Density of Liquids and Saturated Vapours as a function of Temperature.* **C. del Lungo.** (Roma R. Accad. Lincei Atti, 7. 2. pp. 353–358, 1898.)—Let N be the number of molecules per unit of volume of a liquid in presence of its saturated vapour. Let ϵ be the velocity which is sufficient for a molecule arriving at the boundary to overcome the attraction of the liquid, and pass into the vapour. Let $\frac{n}{N}$ be the proportion of the molecules in unit of volume of the liquid whose velocity exceeds ϵ. Then, according to the author, since in equilibrium n is constant, the state of things is the same as if we had a gas containing n molecules per unit of volume permeating uniformly both the volume occupied by the liquid and that occupied by the vapour, and in addition a liquid with $N-n$ molecules per unit of volume. Hence if d be the density of the vapour, D that of the liquid, $\frac{n}{D} = \frac{n}{N}$. And at the critical temperature $d=D$, $n=N$.

If we make $z = \epsilon\sqrt{h}$ where the absolute temperature is $\frac{3}{2h}$ we get—

$$\frac{d}{D} = \frac{2}{\sqrt{\pi}} z e^{-z^2} + \frac{2}{\sqrt{\pi}} \int_z^{\infty} e^{-t^2} dt$$

from which equation the author derives his results. S. H. B

61. *Liquid Mixtures* (Part II.). **R. A. Lehfeldt.** (Phil. Mag. 46. pp. 42–59, 1898.)—Measurements were made on mixtures of alcohol-benzene, alcohol-toluene, carbon tetrachloride-benzene, and carbon tetrachloride-toluene, giving the total vapour pressure in the neighbourhood of 50°—by the dynamic method—and the composition of the vapour—determined by means of the distillate. The apparatus used is described; the mixtures were analysed by their refractive index and tables of the refractive indices of the mixtures are given. From the experimental results, the partial pressures of the components are calculated, and show characteristic differences between the behaviour of alcohol and that of the normal organic liquids. Linebarger's rule for calculating the molecular complexity of liquids (Journ. Amer. Chem. Soc., vol. 17, No. 8) is discussed in the light of these numbers, and concluded to be incorrect. The results are compared with a thermodynamic relation between composition of liquid, composition of vapour, and vapour pressure (Lehfeldt, Phil. Mag. (5) 40. 398) and found in moderate agreement with it; and it is found that the relation

$$\log t = \log k + r \log q$$

holds over a wide range, for normal mixtures (those not containing alcohol), where t is the ratio of masses in the vapour,

q " " " " liquid,

k, r, are constants.

But this relation is purely empirical and does not hold for very dilute solutions of either liquid in the other. AUTHOR.

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62. *Irreversible Processes.* **O. Wiedeburg.** (Wied. Annalen, 64. 3. pp. 519–548, 1898.)—In continuation of his previous papers (see 1898 Abstracts, Nos. 32 and 739) the author states that the main point advocated by him as against the prevailing opinion is the constancy of the "heat contents" of a body, which cannot be transformed into other forms of energy. For the theorem of the constancy of the sum of the quantities $c\ d\ \theta + c'\ d'\ \theta$ we must substitute the law of the constancy of the total energy. The occurrences in the calorimeter especially should be represented by equations between energies, not quantities. The conception of "entropy" due to Clausius is identical with the old idea of "heat contents." The specific heat of a body is independent of its condition and its manner of changing it. As regards the specific heat of pure metallic solids, the author deduces several laws from his theoretical considerations which are confirmed by experiment. E. E. F.

SOUND.

63. *Vowel Sounds.* **Marage.** (Journ. de Physique, 7. pp. 449–455, 1898.)—When investigated by means of photographs of manometric flames, the (French) vowel sounds I, U, OU are seen to be characterised by the vibrations of a single flame, and A by those of three flames. E, EU, and O are formed by superimposing the A sound upon I, U, and OU respectively, and the appearance presented is that of the vibration of two flames. In singing, the spoken vowel sound is usually drowned by the sound proceeding from the vocal chords. In many instances the singer has the choice between mispronouncing the vowel and singing sharp or flat. The resonances of the nasal and buccal cavities must be suppressed in favour of the laryngeal note.

E. E. F.

64. *Vowel Sounds.* **Monoyer.** (Comptes Rendus, 126. pp. 1637–1639, 1898.)—The 15 vowel sounds of the French language may be arranged in a scheme based upon the sounds of *ou*, *u*, and *i*, which have an interval of an octave each between them. The sounds of *oh* and *ah* occur within the first octave, and those of the obscure *e* and the open *e* in the second octave, being in each case represented by *re* and *fa* respectively. The nasal vowels *on*, *an*, *un*, and *in* are produced by the addition of a constant note which resounds in the nasal cavity. All the above remarks apply to whispered vowels, as whispering is the only means of eliminating the fundamental laryngeal note. E. E. F.

65. *Photography of Manometric Flames.* **E. L. Nichols** and **E. Merritt.** (Phys. Rev. 7. pp. 93–101, 1898.)—The work described in this paper was undertaken in order to determine to what extent the manometric flame, with the aid of photographic methods, could be made useful in the study of the human voice. A specially suitable manometric flame was obtained by burning a jet of mixed acetylene and hydrogen in a stream of oxygen. A series of fine photographs are given, including records of several words. The highest speed attained by the celluloid film was 5 m. per second. It was found that in ordinary speech the pauses between words are not longer than those between syllables. Most of the high and delicate overtones of the sibilant consonants cannot be traced in the records obtained. E. E. F.

ELECTRICITY.

66. *Electrostriction and Electrodynamic Equation of a Moving Material Medium.* **J. Larmor.** (Roy. Soc. Proc. 63. pp. 365-372, 1898.)—In this note, intended as a supplement to his third memoir, the author justifies his assumptions of the former memoirs concerning the kinematical properties of ether. These being assumed, it remains to transform the molecular equations, which have to do with separate molecules, into differential equations which take cognisance only of the properties of an element of volume. When this transformation leads to infinities, the difficulty is to be evaded by the use of a principle which the author calls *the mutual compensation of molecular forcives*—that is, the infinite term represents a finite part of the result depending solely on the local molecular configuration, and the principle asserts that it may be omitted in estimating the mechanical effect on an element of volume. Without in the present paper giving the demonstrations, the author gives the general results at which he arrives, and shows that they satisfy Ampère's circuital relation, and also satisfy Faraday's circuital relation, provided the velocity attributed to moving matter is uniform in direction and magnitude. He discusses further the phenomena referred to in Arts. 79, 80 of the former memoirs. S. H. B.

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67. *Axial Field of a Bobbin in the form of a Truncated Cone.* **L. Houllevigue.** (Journ. de Physique, 7. pp. 466-468, 1898.) I is the current in C.G.S. units, n the number of turns per unit length measured along the slope of the cone, β the angle the slope makes with the axis, α_1 and α_2 the angles lines joining the larger and smaller bases and any point P in the axis make with the axis respectively.

Then the field at P or

$$f = 2\pi n \mathrm{I}\left[\sin^2\beta \log \frac{\tan\dfrac{\alpha_1+\beta}{2}}{\tan\dfrac{\alpha_2+\beta}{2}} - \cos(\alpha_1+\beta) + \cos(\alpha_2+\beta)\right]$$

At the summit of the cone the above expression becomes indeterminate but can be evaluated as

$$f_s = 2\pi n \mathrm{I} \sin^2\beta \log \frac{\mathrm{R}_1}{\mathrm{R}_2}$$

R_1 and R_2 being the radii of the larger and smaller bases respectively.

The author has employed this form of bobbin to regulate the interior axial field of a cylindrical bobbin. A bobbin is taken of length equal to ten times its radius, the two ends are thinned down to form truncated cones over a length equal to three radii, the radius of the smaller base being 3/4 that of the cylinder. The axial field within two radii on either side of the centre does not vary one in 1,000, while in the case of an ordinary cylinder of the same dimensions the variation is 11 in 1000 for the same length.

E. C. R.

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68. *Electromagnetic Theory*. **O. Heaviside.** (Electrician, 41. pp. 154–156, 323–325, 549–552, and 783–786, 1898.) A series of articles on this subject. EDITOR.

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69. *Electric Density on an Insulated Ellipsoidal Conductor.* **E. Armanini.** (N. Cimento, 7. pp. 377–382, 1898.) If a, b, c, be the semiaxes of the ellipsoid h the electric density at the point x, y, z, on its surface, e the total charge, it is known that

$$h = \frac{e}{4\pi a b c\sqrt{\dfrac{x^2}{a^4}+\dfrac{y^2}{b^4}+\dfrac{z^2}{c^4}}}$$

If k be a parameter defined by

$$\frac{x^2}{a^4}+\frac{y^2}{b^4}+\frac{z^2}{c^4} = k^2 \qquad (1)$$

$$h = \frac{ck}{4\pi abc}$$

Hence the lines of constant density on the ellipsoid are the lines of constant k, that is the intersections of the given ellipsoid by the family of ellipsoids whose equations are (1). In order that the intersection may be real it is found that, a and c being the greatest and least semiaxes, $a \gtrless k \gtrless c$.

By a somewhat similar method can be found the lines of greatest variation of density. S. H. B.

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70. *Diurnal Variation of Atmospheric Electricity.* **Chauveau.** (Paris, Soc. Franc. Phys. Bull. 120. pp. 1–3, 1898.) The author, from the readings obtained at the Central Meteorological Bureau (Paris) and the Eiffel Tower, comes to the following conclusion: (1) At the Meteorological Bureau there are two maxima (7 to 8 p.m., and 7 to 10 a.m.) and two minima (one in the afternoon, the other during the night between 3.30 and 4.30 a.m.). (2) At the same place in summer the minimum in the afternoon is much more pronounced than that at night, although the latter

is clearly marked. In winter the minimum in the afternoon and the maximum in the morning are only feebly indicated. (3) At the Eiffel Tower in summer the atmospheric electricity has only one maximum and one minimum, and thus resembles the conditions found near the surface (at the Bureau) in the winter. The author finds that measurements made in towns or even near railways are quite unreliable. W. W.

71. *Diurnal Variations of Terrestrial Magnetism.* **G. Lüdeling.** (Berlin Akad. Sitzber. 36. pp. 524–530, 1898.)—By combining the diurnal variations in the north-south X component of the horizontal magnetic force with the east-west Y component, Bezold has obtained his vector diagrams, which form closed, but very irregular curves, which he refers to the astronomic and not to the magnetic (Lloyd, Airy) meridian. Calculating these values for June and July, 1883, for the observatories at Cape Thorsden, Jan Mayen, Bossekop, Sodankylä, Godthaab (latitudes from 78 down to 67°) and further for Pawlowsk (lat. 59° 41′), Lüdeling finds that the movement of the radius vector in the polar regions is counter clockwise, if all days are considered, but clockwise—as generally in medium latitudes (Schuster) and also at Pawlowsk—if quiet days alone are taken. All the vectors cross the astronomic meridian before noon (between 10 and 11.30) and again more than 12 hours later. Other polar stations show similar relations; but the curve for Kingua Fjord (lat. 66° 36′, long. 67° 19′ W.) is always, winter and summer on quiet and disturbed days, a fairly regular oval with a clockwise motion. It would appear that the variations and the disturbances, though both ultimately to be traced back to the sun, may have different causes. H. B.

72. *Magnetic Elements at Potsdam,* 1897. **M. Eschenhagen.** (Wied. Annalen, 65. 4. pp. 951–952, 1898.)—The following are the values for 1897 in absolute measure:—

	Values.	Difference from 1896.
Declination...............	10° 9·7′ W	— 4·6′
Horizontal Intensity ...	0·18775 c.g.s.	+ 0·00028
Vertical Intensity	0·43398 c.g.s.	— 0·00006
Dip	66° 36·3′ N	— 2·1′
Total Intensity	0·47286 c.g.s.	+ 0·00007

Magnetic storms were observed on Jan. 2, April 2, 20, 23, Dec. 11, 20, 21.

The magnetic survey during 1897 was carried out at 32 stations lying within a radius of 40 kilometres of Potsdam. The observatory is threatened by the extension of the electric tramways. E. E. F.

73. *Lightning Discharges from Transmission Lines.* **C. P. Steinmetz.** (Elect. World, 32. pp. 203–205, 1898.)—A mathematical paper dealing with the problem of the oscillating discharge of a transmission line when charged by induction from a thundercloud. The conclusion arrived at by the author is that the fundamental frequency of the discharge is relatively low, and of not much higher magnitude than frequencies in commercial use. A. H.

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74. *Dielectric Properties of Ice.* **R. Abegg.** (Wied. Annalen, 65. 4. pp. 923–925, 1898.)—In a previous paper (see 1898, Abstract No. 1058) the author stated that Nernst's dielectric apparatus was unsuitable for the measurement of dielectric constants of bodies such as ice. Subsequent experiments have proved this to be erroneous. E. E. F.

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75. *Multiplication of the Secondary Discharge of a Condenser.* **R. Swyngedauw.** (Comptes Rendus, 126. pp. 1788–1789, 1898.)—The circuit joining the armatures of a jar contains a primary exciter and coil, and subsequently bifurcates into two branches, one interrupted by the interpolar space of a secondary exciter, the other consisting of a secondary coil; the branches come together again, and their junction is connected by a short conductor to the second armature. It has been shown experimentally that, if the secondary spark-gap exceeds a certain limit, the quantity of electricity which passes through the secondary coil is far greater than the charge of the condenser. The author states that he has succeeded in accounting for this by applying the general laws of induction. The actual analysis is not given. It appears that the augmentation of the secondary discharge cannot occur unless that in the principal circuit is alternating. G. B. M.

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76. *Discharge of Condensers.* **A. Garbasso.** (Torino, R. Accad. Sci. Atti, 33. pp. 436–444, 1897–98.)—A large Leyden is discharged through a circuit, part of which consists of two parallel branches, one of much greater resistance than the other. By means of a commutator, a spark-gap may be inserted in one or the other branch. The sparks are observed by a rotating mirror arrangement. The discharge through the thick branch is always clearly alternating; that through the thin one seems to be occasionally aperiodic, but more frequently oscillating and rapidly damped. The author describes an apparatus which shows what is (roughly) a hydrodynamical analogue. G. B. M.

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77. *Dielectric Strength of Air.* **C. P. Steinmetz.** (Amer. Instit. Elect. Engin. 15. pp. 327–372, 1898.)—This is a continuation of the author's researches on high voltage discharges. The apparatus used is a series of step-up transformers as described in Abstract No. 509, 1898. The following results are arrived at:—

1. At constant voltage and constant wave shape, that is constant ratio between maximum and effective E.M.F., the striking distance (in air) is a constant, especially between sharp points, where the tests have been repeated over and over again, and independent of the atmospheric condition, the frequency, &c., to such an extent that the striking distance between needle-points offers the most reliable means to determine very high voltages. For this reason it is used as a final check in all high potential insulation tests of the General Electric Company.

2. No physical law has been found to represent satisfactorily all the observations. Some point to the existence of a constant dielectric strength of air, analogous to the tensile strength of mechanics. Others point to the existence of a spurious counter E.M.F. of the spark or transition resistance from electrode to air.

3. Constant dielectric strength. Cylinders of 1·11" diameter give an average disruptive strength of air of 60 kilovolts per inch; cylinders of 0·315" diameter, an average dielectric strength of 77. Spheres at a very small distance point toward the latter value. As a disturbing factor in this case, enters the electrostatic brush discharge, which, by a partial breakdown of the air surrounding the electrodes, changes and increases the size and decreases the distance of the effective terminals.

4. Counter E.M.F. of the sparks. The tests with sharp points give 22 kilovolts, or 11 kilovolts for a single transition from terminal to air. Spheres give curves pointing to a similar phenomenon. Electric conductors inserted at right angles into or parallel with the discharge point to the existence of a counter E.M.F. of the same magnitude. The beginning of the electrostatic brush discharge is at a potential of this magnitude also.

5. Potentials of 160,000 volts effective and even up to 170,000 volts have been experimented with. They are probably the highest voltages ever reached at ordinary frequencies with alternating currents of considerable power—about 30 kilowatts.

W. G. R.

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78. *Electric Discharge in a Liquid Dielectric.* **L. Décombe.** (Comptes Rendus, 126. pp. 1197–1198, 1898.)—When the electric discharge takes place across a liquid dielectric, its character appears different from that seen in the case of air. When a spark through oil of vaseline was studied by means of a rotating mirror there was found to be no alternation from one extremity of the image to the other, as if at the same instant the spark possessed the same brightness over all its length. The volatilisa-

tion of the metal at the negative electrode seems hindered by the presence of the liquid, a tearing away of solid incandescent particles as at the positive electrode takes place, the spark then would be entirely made up of solid incandescent particles, of which the brightness would follow a periodic law synchronous with that of the discharge. J. J. S.

79. *Discharge of a Leyden Jar.* **R. Swyngedauw.** (Comptes Rendus, 126. pp. 1628–1630, 1898.)—A Leyden jar is discharged round a circuit of two coils in series. The author concludes from his experiments that the discharge current is uniform, and that the maximum potential, V, attained between the extremities of the double coil is the sum of the maximum potentials, v_1 and v_2, attained at the extremities of each of the coils.

$$V = v_1 + v_2$$

and—

$$V = (L_1 + L_2)\frac{dC}{dt}$$

J. J. S.

80. *Variation of Gaseous Pressure in Vacuum Tubes.* **G. Séguy.** (Comptes Rendus, 127. pp. 385–387, 1898.)—The pressure in a vacuum tube traversed by an electric discharge is neither uniform nor constant. This may be proved by means of a glass tube 4 m. long, bent double in lengths of 25 cm., and provided with electrodes at the two ends. It is exhausted to a millionth of an atmosphere and connected with an induction coil or a transformer. It is found that while at the kathode end the original exhaustion is maintained, the exhaustion at the anode falls to one-thousandth of an atmosphere, as shown by the usual forms of discharge. The portion of the tube near the anode is soon filled with gaseous molecules. On reversing the current, these molecules are pushed into the other half of the tube. The author supposes that the metallic particles projected from the kathode aid in maintaining the vacuum there by sweeping the gaseous molecules into the walls of the tube.

E. E. F.

81. *Vacuum Tubes.* **L. Bonetti.** (Comptes Rendus, 126. pp. 1893–1894, 1898.)—The author varies the degree of vacuum within a vacuum tube, regenerating a tube which has become too hard by subjecting a platinum wire within it to incandescence by means of an electric current. A. D.

82. *Circulation of Gaseous Matter in Crookes Tubes.* **A. A. C. Swinton.** (Phil. Mag. pp. 387–395, 1898.)—Radiometer mill wheels are employed to detect the return stream of the particles that form the kathode rays. Such wheels, when arranged in high vacuo, so as to be just outside the kathode stream, are found to rotate in a direction that indicates a return stream from the anode to the kathode outside of the opposite kathode stream. Mills both of paddle-wheel and screw-propeller form give this result, and gilding the mica vanes does not materially affect matters. The action cannot therefore be due to electrification, nor does it appear to be caused by thermal radiation. The author suggests that while at low exhaustions the discharge may be conveyed through the tube by an interchange of electrical charges from molecule to molecule on the Grotthus chain principle; at high exhaustions there may to some extent be a complete circulation of the positively and negatively charged atoms, some of which may make the entire journey from anode to kathode or *vice versâ*, and deliver up their charges not by interchange with other gaseous atoms, but by direct convection to the electrodes of apposite sign. AUTHOR.

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83. *Kathode Fall of Potential in Gases.* **J. W. Capstick.** (Roy. Soc. Proc. 63. pp. 356–365, 1898.)—A current from a battery of storage cells was sent through the gas, which was at a pressure of 1 or 2 millimetres. When the current is constant the fall of potential between the kathode and a point just outside the negative glow is independent of the current strength and of the pressure of the gas. This fall of potential was measured for several gases, with the following results:—

Hydrogen	298 volts
Nitrogen	232 „
Oxygen	369 „
Water vapour	469 „
Ammonia	582 „
Nitric Oxide	373 „

The accuracy of the last is doubtful, for the gas is very rapidly decomposed by the current, and a trace of oxygen has a large effect on the kathode fall. Leaving nitric oxide out of account, the values found are approximately additive. In the elementary gases the current is generally continuous, but in the compound gases it is almost always intermittent, which makes readings difficult to obtain for these. AUTHOR.

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84. *Chemical Action of Kathode Rays.* **J. J. Thomson** and **S. Skinner.** (Cambridge Phil. Soc. Proc. 9. 7. pp. 371–372,

1898.)—Aluminium is rapidly evaporated from a kathode by the electric discharge in a highly exhausted vacuum tube containing mercury vapour. The metal forms a bright mirror on the walls of the tube. An iron kathode gives a similar mirror in mercury vapour. When the aluminium coating is dissolved off by hydrochloric acid, a gelatinous membrane of silica is left. The iron mirror dissolves away completely. Possibly the aluminium driven off from the kathode acts on the glass, forming a silicide. When potassium vapour is used in the place of mercury vapour, the glass opposite the kathode is roughened, although the aluminium is not extensively evaporated. Parts protected by screens are not attacked. In this case the action on the glass may be attributed to the potassium driven against it by the kathode discharge. Opposite the kathode, both in mercury and potassium vapours, a dark annular stain of the shape of the kathode is formed. The stain appears to be carbon, but the quantity was too small for definite tests. It is formed on mica, quartz, and calcite screens. Monatomic gases appear to especially facilitate the evaporation of carbon, as Professor Callendar has observed its evaporation in argon vacuum tubes. S. S.

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85. *Kathode Rays.* **P. Villard.** (Comptes Rendus, 126. pp. 1564–1566, 1898.)—From the results of his experiments, in which a reducing action is exerted by the kathode rays, the author is led to the conclusion that they consist of particles of hydrogen, which he thinks is furnished by the imperfectly dried glass, there being no means of completely getting rid of the water by drying agents. J. J. S.

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86. *Kathode Rays.* **P. Villard.** (Comptes Rendus, 127. pp. 173–175, 1898.)—Two bundles of kathode rays have no appreciable action upon one another when they cross, unless one of the bundles encounters lines of force. The behaviour of kathode rays under variations of form and position is discussed. A. D.

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87. *Reflection of Kathode Rays.* **H. Starke.** (Wied. Annalen, 66. 1. pp. 49–60, 1898.)—Kathode rays are projected from a side tube into a spherical vessel, in the centre of which a flat metallic mirror is mounted, which can be moved about a vertical axis from outside. After reflection, the rays are caught in another side tube at an angle of 60° to the first. This side tube contains an electrode constructed on the model of Faraday's ice-pail. The results show that the reflection is diffused, since the galvanometer shows the same deflection whatever the orientation of the mirror, provided the same face is turned towards the two electrodes. The reflection is considerably

reduced by connecting the mirror to earth and thus discharging the kathode particles. The reflective powers of various metals are in the same order as their densities, but not in the same proportion. E. E. F.

88. *Period of Electrical Oscillations.* **A. G. Webster.** (Phys. Rev. 6. pp. 297–314, 1898.)—The electrical oscillations considered are set up by the discharge of an air-condenser through a coil of copper wire wound inductively, the capacity of the condenser and the inductance of the coil being calculable from their dimensions. The condenser and both pairs of quadrants of a Mascart-Kelvin electrometer are charged to the same high potential; an electrical contact is broken, causing one pair of quadrants to discharge suddenly, and the condenser and the other pair of quadrants to discharge in parallel in an oscillatory manner through the inductive resistance. At a measured interval after the commencement of discharge the electrometer quadrants are insulated, thus showing the condenser potential at the end of the interval. The interval is obtained by the free fall of a projectile liberated by an electromagnetic device, and the author describes the precautions necessary for securing an accurately straight fall; the contacts are broken successively by the impact of the projectile against levers. The results give for "v" the value $3{\cdot}0259 \times 10^{10}$ cm. per sec. and confirm the formula for the period of condenser oscillations. J. L. H.

89. *Electric Oscillations.* **Drude.** (Zeitschr. Elektrochem. 4. pp. 492–494, 1898.)—For each given wave-length each substance has a particular dielectric constant and a particular coefficient of absorption. The latter can in many cases be calculated from the conductivity, the period of oscillation and the dielectric constant; in others not. In these latter cases of abnormal absorption, the absorption is much greater than corresponds to the conductivity: thus amyl alcohol absorbs waves 75 cm. long in much the same proportion as a saline solution of 20,000 times its conductivity. Abnormal absorptions seem to be associated with the presence of hydroxyl-groups: and in such cases the dielectric constant rapidly falls off as the period of oscillation diminishes. A. D.

90. *Hertzian Oscillations and Metal.* **E. Branly.** (Comptes Rendus, 127. pp. 43–46, 1898.)—Electrostatic induction does not act within a metal cage: current induction does; but Hertzian oscillations are completely excluded even by a very thin-walled metal cage if it be hermetically closed, or if the metal be a very fine gauze: not if there are any linear apertures in it. The amount of action within varies with the size and direction of the slit. A. D.

91. *Hertzian Field in Air and in Oil.* **A. Turpain.** (Comptes Rendus, 126. pp. 1630–1632, 1898.)—A Hertzian resonator kept in the same plane as the wires which concentrate the field (position II.) discloses a system of nodal and ventral segments alternating with those which it indicates in the classical position, perpendicular to the direction of the wires (position I.), the nodes of one of the systems coinciding with the loops of the other and inversely.

From his experiments conducted in air and in oil the author concludes that—

1. The wave-lengths revealed by a resonator kept in position I. vary with the nature of the dielectric in the midst of which the phenomena occur. They are less in oil than in air.

2. For position II. the wave-lengths are independent of the nature of the dielectric in which they are measured. They are equal in air and in oil. J. J. S.

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92. *Electric Resonators.* **Oudin.** (Comptes Rendus, 126. pp. 1632–1634, 1898.)—A description of the effects got with the author's high frequency apparatus. He now uses a solenoid of fine copper wire, not insulated, coiled on a cylinder of paraffined wood. The high frequency may be obtained by an influence machine or by the arrangements of Hertz or Tesla, but best by d'Arsonval's method in which a spark passes between the inner coatings of two Leyden jars. From the last spire of the resonator bright luminous tufts or plumes dart out. The resonator creates in the region around it a very intense alternating electrostatic field, and sparks may be drawn from surrounding metallic objects. Sparks may also be got from the body of a person whose hand is placed near the discharge. The physiological effects are referred to and the action on a Crookes tube. The prolonged action of the high frequency discharge on the skin produces results analogous to those of Röntgen rays. J. J. S.

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93. *Electromagnetic Waves.* **C. Gutton.** (Comptes Rendus, 127. pp. 97–100, 1898.)—If Hertzian waves are transmitted along two parallel wires whose extremities are joined by a bridge the electric force is constantly zero at the middle of this bridge. The author has sought to find how the passage of the waves takes place over a secondary wire arranged parallel to the primary wire in the region near the point of zero electric force. Waves transmitted from the same exciter along parallel wires arrive at the same resonator at the ends of the wires in concordance; if one of the wires is interrupted and the wave transmitted to a secondary wire by means of a bridge of two concentric circular wires a difference of phase of a half-period is introduced. As to the effect on the form of the train of waves of passing from one wire to another, it is found that the exciter sending out damped

pendular vibrations, the secondary waves are of the same form, and have the same period and the same damping, only the amplitude of the vibration is diminished by the passage of the waves to the secondary conductor. The author explains these results by a consideration of the behaviour of the lines of force.

J. J. S.

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94. *Dielectric Hysteresis.* **H. Benndorf.** (Wied. Annalen, 65. 4. pp. 890–893, 1898.)—A paper similar to that referred to in Abstract No. 1241, 1898. E. E. F.

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95. *Internal Resistance of Standard Cells.* **I. Klemenčič.** (Wied. Annalen, 65. 4. pp. 917–922, 1898.)—The author points out the importance of the internal resistance of standard cells in certain standardising operations. Some of the standards manufactured according to the Reichsanstalt precepts show enormous variations of resistance with temperature. One of them, made by Fuess, had 8,620 ohms at 20·8° and 30,800 at 11°. The straight form of the Clark cell, though inferior as regards E.M.F., has distinct advantages over the H-form in the matter of resistance.

E. E. F.

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96. *Resistance of the Human Body.* **J. E. Boyd.** (Phys. Rev. 7. pp. 115–118, 1898.)—A reading was taken with a Duncan dynamometer in series with a non-inductive resistance of 1,550 ohms which was then replaced by the body. The fingers were dipped into a solution of ammonium chloride, two large battery carbons forming the electrodes. For alternating currents of from 2 to 7 volts, 0·0014 to 0·0044 ampere and 62 periods, the resistance, hand to hand, varied between 1,478 and 1,622 ohms; for continuous currents of about the same strength and tension betweeen 1,598 and 2,078 ohms. In a second series of tests, Ayrton's method was applied, the current being measured by a Weston voltmeter, and the drop of potential with a condenser and galvanometer. Platinum foil strips, fastened to the body, served as condenser terminals. By this method the total resistance, jar to wrist, wrist to wrist, wrist to jar, aggregated 1,334 ohms. The hands above the liquid were not thoroughly dry; hence probably the smaller resistance. H. B.

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97. *Resistance of the Human Body.* **Dubois.** (Comptes Rendus, 126. pp. 1790–1792, 1898.)—In these experiments a condenser is connected with a battery for a very short period by means of a steel ball impinging on a mass of steel and rebounding. Various resistances are inserted in the path of the current,

and the results compared by means of a ballistic galvanometer. The author concludes *inter alia* that during the state of variable flow the resistance of the human body is much less than its ohmic resistance; that this resistance is unaltered, for the same position of the electrodes, in spite of large variations of the ohmic resistance; and that the body, considered as a condenser, has a capacity of about 0·165 microfarad. G. B. M.

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98. *Resistance of Incandescent Lamps.* **J. C. Schedd.** (Amer. Electn. 10. pp. 362–363, 1898.)—The author gives three definitions of electrical resistance, and applies them to the design of incandescent lamps. The variable temperature-resistance coefficient of carbon filaments, and the effect of abnormal temperatures on their resistance, are also discussed. A. H. A.

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99. *Measurement of Resistance of Incandescent Lamps.* **R. Apt** and **H. W. Hoffmann.** (Écl. Électr. 14. pp. 566–569, 1898; and Elektrotechn. Zeitschr. p. 122, 1898.)—The method usually employed for the above purpose is not strictly correct, the resistance being deduced from ammeter and voltmeter readings; the current taken by the latter, of course, introduces an error. The method suggested by the authors is a modification of that employed by E. Wiedemann, in which a Wheatstone bridge is used—the lamp being inserted in one of the branches. This method, although more accurate that the preceding one, does not make use of all the advantages of the Wheatstone bridge test. The authors propose to employ the bridge by causing an auxiliary current to pass through the lamp in addition to the main current. The connections are analogous to those of the Paalzoid and Rubens bolometer method. The above method possesses the disadvantage of being somewhat complicated, and also that if one of the lamp circuits is accidentally broken a strong current will pass through the battery and galvanometer and may injure them. L. J. S.

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100. *Conductivity of Hot Gases from Flames.* **J. A. McClelland.** (Phil. Mag. 46. pp. 29–42, 1898.)—In this paper the nature of the conductivity which is observed in gases coming from flames is investigated. The flame used is that of an ordinary Bunsen burner, and the gas is drawn along a brass tube in which is placed an insulated terminal which can be raised to any required potential, and the conductivity is given by the rate of leakage of this terminal as shown by an electrometer.

The relation between current and E.M.F. is investigated, and the result shows that the conductivity is due to the ionisation of the gas in the flame. We have, then, a number of positively and negatively charged carriers which give to the gas its conductivity. The velocity of these carriers under an E.M.F. is measured by a method described in the paper, and found to be ·2 cm. per second for a potential gradient of 1 volt per cm. This velocity is much less than has been found for the carriers in gas which has been exposed to Röntgen rays, and points to the carrier having joined on to itself a number of uncharged particles, which increase its mass without increasing the charge, and thus diminishing the velocity.

A difference between the velocity of the positive and negative carriers was also detected, the velocity of the negative being about 15 per cent. greater than that of the positive. As the charges of the positive and negative carriers are probably the same, the positive must have more uncharged particles attached to it. The velocity of the carriers was found to diminish rapidly as the gas cooled at some distance from the flame, which would point to a further condensation on the carrier of some uncharged body.

At a distance from the flame the gas loses a much smaller percentage of its conductivity by passing through fine gauze than if the gauze is placed nearer the flame. This is explained by the diminished velocity of the carrier under an E.M.F. at a distance from the flame, so that fewer carriers come into contact with the gauze by diffusion. The rate of recombination of the positive and negative carriers is also investigated, and is approximately proportional to the square of the number present. AUTHOR.

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101. *Electric Conductivity of Flame Gases.* **K. Wesendonck.** (Wied. Annalen, 66. 1. pp. 121–135, 1898.)—The flame gases examined were the products of combustion of a Bunsen burner, aspirated through a cooling chamber and a wash-bottle into a jar containing a charged disc connected with an electrometer. Any remaining conductivity was thus indicated by a discharge of the electrometer. It was found that while cotton- or glass-wool completely abolished the conductivity of flame gases, bubbling through water had no effect whatever upon it. Bubbling through mercury, sulphuric acid, permanganate of potash, turpentine, and glycerine, were equally inefficient. Hot sulphuric acid was the only means of completely discharging the gas. The result was the same with a negative as with a positive charge. The number of dissociated ions is probably infinitesimal in comparison with the number of undissociated ions in the gas. E. E. F.

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102. *Measurement of Single Potential Differences.* **H. R. Carveth.** (Journ. Phys. Chem. 2. pp. 289–321, 1898.)—The first part of this paper contains a review of the methods which

have been used to determine single differences of potential, *i.e.*, that of Lippmann by using the capillary electrometer, and that of dropping mercury into an electrolyte. In the second part a series of experiments are made by the dropping mercury method. The potential difference between a given metal and an electrolyte, into which the mercury drops, is measured by connecting the metal and mercury to a potentiometer. The measured potential difference is found to vary with the concentration of the electrolyte. The values are not in agreement with those of Paschen obtained by the same method, nor with those obtained by the Lippmann method.

The principal conclusion to be drawn is that neither on the ground of the Helmholtz theory, the Warburg theory, nor that of Nernst is there reason for regarding one single potential difference as known. Cases where the dropping electrode gives values corresponding to the polarisation method have been observed, as well as cases in which a difference occurs. It is found that the values obtained for different concentrations follow in regular order, and that both the anion and kation affect the values. Nernst's solution pressure formula holds approximately in a few cases, but in the great majority fails. The main query of the paper, "Are the values given by the drop electrodes true single differences of potential?" must be answered in the negative.

S. S.

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103. *Electric Arc.* **J. Sahulka.** (Zeitschr. Elektrotechn. Wien, 16. pp. 213–216, 1898.)—When one end of a galvanometer circuit is joined to one of the electrodes of an alternating arc, and the other to a small auxiliary carbon which is inserted in the arc, indications of a direct electromotive force are obtained. The author discusses the theory of this, and gives the results of some of his own experiments.

G. B. M.

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104. *Thermo-Electromotive-Forces in Crystallised Bismuth.* **L. Perrot.** (Comptes Rendus, 126. pp. 1194–1197, 1898.)—A comparison has been made between the thermo-electric forces in crystallised bismuth when the current traverses the bismuth perpendicularly to the principal cleavage and when it traverses it parallel to this cleavage. Junctions of copper and bismuth were used, and the electromotive forces were measured by two methods: (1) by the deflections directly produced on a sensitive galvanometer, (2) by the potentiometer method.

The following are the general results:—

1. The E.M.F. for 1° difference between the temperatures t and t' of the junctions goes on increasing with the temperature between 10° and 100°.

2. This increase is more rapid for the junctions where the surfaces of contact are perpendicular to the cleavage than for the

junctions where the surfaces are parallel to the cleavage; hence the ratio of the E.M.F.'s (parallel: perpendicular) goes on diminishing in proportion as $(t + t')$ increases. In one of the experiments t being kept at 11°, the ratio when t' was 20° was 2·33; when t' was 100° the ratio was 2·00.

3. As to the absolute values of the electromotive forces: the temperature of the cold junction t being 11°, the E.M.F. in volts was:—

For t'	30°	50°	70°	95°
Parallel to cleavage	0·00190	0·00396	0·00610	0·00899
Perpendicular to cleavage	0·00084	0·00185	0·00299	0·00447

The results indicate that the crystalline structure has on the thermo-electric constants of bismuth a greater influence than has hitherto been supposed. J. J. S.

105. *Theory of Coherers.* **D. van Gulik.** (Wied. Annalen, 66. 1. pp. 136–145, 1898.)—Some experiments are described which should decide between the coherer theories put forward by Lodge and Branly respectively. The action of electric waves upon a gap between the spherical ends of two thin platinum wires, as observed under the microscope, drew the ends together when their distance apart was reduced to 0·004 mm. They remained sticking together after the radiation had ceased. In another experiment two mercury drops, separated by a thin surface contamination of chalk, coalesced under the influence of electric radiation. These experiments prove that actual metallic contact is created, and controvert Branly's hypothesis of a modification of the intervening dielectric. E. E. F.

106. *Materials for Coherers.* **E. Dorn.** (Wied. Annalen, 66. 1. pp. 146–161, 1898.)—The noble metals—platinum, gold, and silver—give practically no coherer action. Iron gives good results, especially after a short exposure to air. Copper, immediately after filing, shows no change of resistance. After five hours a slight coherer action is observed, and in three weeks the resistance may rise to 300,000 ohms, which falls to 10 ohms under the influence of electric radiation, and rises to 187,000 ohms on concussion. Neither exhaustion nor heating have any influence upon a tube containing aluminium filings. In tubes containing nickel, iron, copper, or zinc, heating leads to a diminution of the resistance, which in zinc is probably due to sublimation. E. E. F.

107. *Polarisation.* **Heim.** (Zeitschr. Elektrochem. 4. pp. 527–534, 1898.)—The potential difference, p, between the poles of an electrolytic cell with insoluble electrodes for the passage of

a constant current i is equal to e, the polarisation for that current density added to the electromotive force needed to maintain the current through the resistance r of the cell:—

$$p_1 = e + i\,r$$

Again, if the cell is divided completely by a thin wall of the same material as the insoluble electrodes, the resistance r of the cell is practically unaltered, but the value of e is doubled since the current enters one face of the thin septum and passes out from the other. If the current is maintained equal to i, we have for the new potential difference p_2:—

$$p_2 = 2\,e + i\,r.$$

From the two readings of potential difference it follows:—

$$e = p_2 - p_1.$$

The author gives details for carrying out this method, and some examples. S. S.

108. *Differential Telephone for Measurement of Electrolytic Conductivity.* **R. Federico.** (N. Cim. 4. 6. pp. 161–171, 1897.)—The author describes a differential telephone and its application for measuring electrolytic resistances in the same way as a differential galvanometer is used in the case of metallic wires. S. S.

109. *Standards of Measurement.* **H. S. Carhart.** (Science, 8. pp. 326–327, 1898.)—In the determination of the mechanical equivalent of heat by electrical methods, Griffith's results exceed those of Rowland by about 1 part in 400 at all temperatures between 15° and 25° on the nitrogen scale. Those of Schuster and Gannon exceed Rowland's at 19·1° on the same scale by about 1 part in 500. Since the electrical methods employed involve either the current and the E.M.F. of the Clark cell or the square of this E.M.F., and since the E.M.F. of the Clark cell is determined by the silver voltameter, it follows that the current enters into the result as a square. If the discrepancy is due entirely to an error in the value of the ampere, assuming the ohm to be correct, then the ampere should be 1 part in 1,000 to 1 part in 800 larger than the at present accepted value; that is, the electro-chemical equivalent of silver should be increased from Lord Rayleigh's value of 0·001118 to 0·0011191 or 0·0011194.

The method used by Patterson and Guthe at the Ann Arbor physical laboratory, Michigan, was that of a specially constructed electro-dynamometer of large dimensions, and the employment of the torque of a phosphor-bronze wire to equilibrate the counter-torque due to the effort between the stationary and movable coils.

The torque of the wire was measured by observing the period of vibration of a cylindrical brass weight of known mass and dimensions when suspended by the wire. The entire success of this part of the investigation was due to the fact that the whole apparatus was enclosed in a fairly good vacuum. Under these conditions the vibrations could be followed for hours at various intervals; the logarithmic decrement was almost entirely constant, and it was easy to obtain a curve connecting temperatures and periods of vibration. The wire was so connected to the support and to the brass cylinder that it could be transferred from the vacuum apparatus to the electro-dynamometer and back again without disconnecting it from the terminal pins.

The weights employed were compared with the standards at the U.S. Bureau of Weights and Measures in Washington; the standard of length was a half-meter bar of speculum metal made for the University of Michigan by the late W. A. Rogers. The time was taken by a standard Riefler clock, checked by the observatory time. The result of the investigation is that the electro-chemical equivalent of a used solution of neutral silver nitrate, 15 parts by weight of silver salt to 85 parts of distilled water is 0·0011192. This exceeds Rayleigh's value by about $\frac{1}{8}$ of 1 per cent., and causes the discrepancy in the mechanical equivalent of heat to disappear.

The corresponding change in the E.M.F. of the Clark cell will be from 1·4342 to 1·4327 at 15° C. E. C. R.

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110. *Manganin Standard Resistances.* **W. Jaeger** and **St. Lindeck.** (Wied. Annalen, 65. 3. pp. 572–589, 1898.)—A paper similar to that referred to in Abstract No. 647, 1898.

E. E. F.

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111. *Capillary Electrometer.* **C. F. Burgess.** (Amer. Instit. Elect. Engin. 15. pp. 379–388, 1898.)—Describes a form of capillary electrometer that the author has found very convenient for testing, and which is both light and portable.

The electrometer consists of a rather thick glass tube having a platinum wire sealed in the lower end, which is closed. A layer of mercury covers the wire, and the tube is nearly filled with the electrolyte, consisting preferably of dilute sulphuric acid. A capillary tube, made by drawing out a piece of thermometer tubing, rests against the side of the glass, and is firmly held in place by a tightly fitting rubber stopper inserted in the top of the large glass tube enclosing an air space above the electrolyte. A piece of flexible rubber tubing is fitted on the upper end of the capillary, and filled with pure mercury, its upper end being closed by a piece of glass into which a platinum wire is sealed. A pinchcock is put on the rubber tube, so that on compressing it mercury is forced through the capillary, and on slightly releasing the pressure the mercury is drawn back, followed by the electrolyte. The instrument is then ready for use. The glass tube is held firmly upright by a brass collar attached to an ebonite support. A reading microscope having a micrometer eyepiece is held on an adjustable support, and is used for reading the movement of the meniscus. The apparatus is also fitted with a top and bottom contact key, which when up short-circuits the electrometer. If a pressure of over a volt is applied to the terminals electrolytic action takes place, destroying the sensibility. This is readily restored by compressing the rubber tube until a drop of mercury flows through, when on releasing the pressure the instrument is again ready for use. The direction of movement of the meniscus depends on the polarity, and the extent is approximately proportional through a limited range to the potential difference. This is not absolutely so, as it is impossible to get a capillary of perfectly uniform bore; for this reason the instrument should be used as a zero instrument. E. C. R.

112. *Silver Voltameter and Standard Cells.* **K. Kahle.** (Zeitschr. Instrumentenk. 18. pp. 229–240 and 267–276, 1898.)—This is an investigation as to how far the silver voltameter can be relied upon for standardising. In the course of 115 measurements of the amount of silver deposited by the same current during 40 minutes' electrolysis, this amount varied between 0·97134 grammes and 0·97473 grammes. Under perfectly equal conditions as to current density, temperature, and treatment, an accuracy of 1 in 10,000 can be attained. A platinum surface receives somewhat less of a deposit than an already existing silver deposit. Fresh solutions deposit less readily than those which have already been electrolysed. To get rid of all $Ag\,NO_3$ in the deposit, repeated cold washing and subsequent washing for one hour in water at 80° is necessary. The result of the standardising experiments may be summarised as follows:—

Clark cell at 15°: Cadmium cell at 20° = 1·40663.
Also E.M.F. of Clark cell at 15° = 1·4328 int. volt.
E.M.F. of Cadmium cell at 20° = 1·0186 int. volt.
E.M.F. of Clark cell at 0° = 1·4492 int. volt.

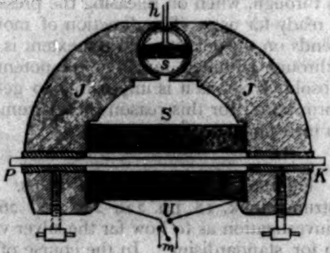
E. E. F.

113. *Ballistic Galvanometry.* **C. Barus.** (Phys. Rev. 7. pp. 10–18, 1898.)—Contains the mathematical theory of a suggested new form of instrument, in which the needle is held against fixed stops by means of a torsion-balance arrangement. G. B. M.

114. *Commercial Permeameter.* **M. Aliamet and E. J. Brunswick.** (Électricien, 16. pp. 187–191, 1898.)—This is a

description of a permeameter constructed by Hubert Kath. A section of the instrument is shown in the accompanying figure. The principle upon which it is based consists in reversing the function of a d'Arsonval galvanometer. Instead of measuring the strength of a current flowing in the movable coil of the apparatus by the deflection of the coil situated in a constant field, a constant current flows round, and the deflections measure variations in the field strength.

The instrument consists of a magnetic circuit composed of the bar *P* of the metal to be studied, and by two iron pole-pieces *J J* of large section and consequently small reluctance. In the polar gap moves the coil. An iron core is placed within the coil to minimise the reluctance of the magnetic circuit. The bar *P* is carefully turned and is held in place by two screws. In series with the magnetising coil *S* are placed two compensating coils on *J J* wound in the opposite sense to eliminate the effect of the pole pieces, so that the flux passing through the coil is due solely to the bar *P*. W. G. R.



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115. *Electrostatic Wattmeter for High-Tension Alternating Currents.* **R. Arnò.** (Torino, R. Accad. Sci. Atti, 33. pp. 593–597, 1897–98.)—The author, having found by experiments on a paraffined paper cylinder in a rotating electrostatic field that for high inductions the work done in hysteresis is proportional to the square of the induction or of the voltage, applies this principle to the measurement of watts in a high-tension circuit. The wattmeter consists of four quadrants surrounding a metallic cylinder, with the paraffined paper cylinder in the annular space between. One pair of quadrants is connected to the two points giving the voltage of the circuit, and the other to the secondary of a transformer on open circuit, through whose primary passes the main current. The author then shows that the deflections of the wattmeter are proportional to the watts in the circuit. G. H. BA.

116. *Correcting Factor of Wattmeter.* **F. Loppé.** (Écl. Électr. 16. pp. 525–530, 1898.)—Taking the general case of a circuit in which the E.M.F. does not follow the sine law, the author deduces an expression (of very considerable complexity) for the correcting factor of a wattmeter in terms of the time-constant of the fine-wire circuit, the ratios of the amplitudes of the various simple harmonic terms which make up the E.M.F. wave, and the resistance and inductance of the main circuit. He then proceeds to show how the expression may (by an exceedingly laborious method) be applied to any given case in practice. A. H.

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117. *Electrostatic Voltmeter.* **Svilokossitch.** (Électricien, 15. pp. 199–201, 1898.)—The paper describes an electrostatic voltmeter constructed by Ebert & Hoffmann on the system adopted by Bjerknes (Wied. Annalen, 48. p. 594, 1893). A rectangular, thin aluminium plate is suspended by a quartz thread between two parallel and vertical metal plates. Its position of rest is at an angle of 45° with the plates, and a difference of potential between the plates produces a force tending to turn it parallel to the lines of force, the deviation, if small, being proportional to the square of the force if the field be assumed uniform. An aluminium wire fixed to the suspended plate carries the mirror, and, at its lower end, a magnet which gives a controlling force and at the same time damps the oscillations by being enclosed in a copper box. The fixed and suspended plates are completely enclosed in a metal case, the former being held by two horizontal rods passing through ebonite bushes in the case and provided with terminals outside. By varying the distance between these plates any desired sensibility may be obtained. A small model gave a deflection of 10 mm. at a scale distance of 1 metre with 64 volts, and without the directing magnet, 150 mm. The small capacity of the instrument renders it suitable for work with electrical oscillations. G. H. Ba.

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118. *Thermal Mercury Ammeter.* **C. Camichel.** (Comptes Rendus, 126. pp. 1028–1030, 1898.)—The thermometric ammeter previously described (see 1898, Abstract No. 412, and Phys. Soc. Abstracts, Nos. 604 and 705, 1897) may be used for the determination of current intensities to within 0·5 per cent. in one minute. Its indications are very constant. It may also be used as a voltmeter for any E.M.F. between 1 and 16 volts. Another type of mercury ammeter may be prepared by making the current pass through a metallic deposit on the bulb of the thermometer tube. E. E. F.

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119. *Action of Induction-coil Condenser.* **A. G. Dell.** (Elect. Rev. N.Y. 33. p. 124, 1898.)—This is a description of some

rough experiments to determine the current, if any, passing between the condenser terminals of an induction-coil and the respective contacts of the make and break apparatus. The experiments, so far as they go, yield no positive results, but they suggest a very useful research. R. A.

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120. *High-Frequency Induction Coil.* **W. P. Boynton.** (Phys. Rev. 7. pp. 35–63, 1898.)—In the work here described the author has endeavoured to verify experimentally the agreement between the actual behaviour of the high frequency induction coil and the results of the approximate theory of an oscillating system with two degrees of freedom. The secondary circuit was used open, *i.e.*, closed by a capacity, and, secondly, closed by a resistance. The frequency used was of the order half a million per second. The primary and secondary potential differences range up to 24,500 volts and 53,700 volts respectively. The chief conclusions may be summarised as follows: (1) The main period of oscillation of the primary circuit is very nearly that deduced from the dimensions of the system. The same agreement is observed in maximum potential attained in the secondary circuit. (2) The effective currents and potentials appear to indicate that the resistances of the sparks are of the order 10 to 100 ohms, depending on the current flowing through the sparks.

E. H. B.

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121. *Pressure of an Induction Coil.* **A. Oberbeck.** (Wied. Annalen, 64. 2. pp. 193–216, 1898.)—In continuation of his previous researches (see 1898, Abstract No. 53), the author has traced some peculiarities of positive and negative discharges as regards electrodes of various shapes. When the electrodes are two spheres the slope of the potential gradient decreases with increasing distance apart, until at 10 cm. the potential remains constant at 30,000 volts for some distance. In the case of blunt points the same thing happens at 7 cm., with 20,000 volts. Afterwards the potentials increase simply with the distances apart. When two points are used, and one of them is put to earth, the negative discharge potential increases rapidly with the distance, but the positive discharge potential, at first higher than the negative, actually decreases at 5 cm. and passes through a minimum of 48,000 volts, increasing rapidly after that. The brush discharge is the only phenomenon which appears to suggest some explanation. It requires only one point, whereas the spark requires two. When the sparking distance is short, no brush discharge takes place, and there is no difference between positive and negative discharge potential if the charge accumulates slowly. But at greater distances the presence of the brush discharge, whose propagation in air depends upon its sign, produces differences between positive and negative spark discharges. E. E. F.

122. *Use of Simple Sine Curves in Alternating Current Problems.* **W. G. Rhodes.** (Elect. Rev. 43. pp. 395–396, 1898.)—In this paper it is shown that for most purposes it is always possible to replace the actual curves of periodic electromotive forces and currents by sine curves having the same root mean square values and periodic time corresponding to that of the fundamental of the actual curves.

This result follows from the fact that—

$$\int^{\frac{2\pi}{p}} e^2\,dt \;,\quad \int^{\frac{2\pi}{p}} i^2\,dt \quad \text{and}$$

$$\frac{p}{2\pi}\int_0^{\frac{2\pi}{p}} ei\,dt$$

are all independent of the relative phase positions of fundamental and harmonics, when e and i are taken to have the most general form, viz. :—

$$e = e_1 \sin(pt + \alpha_1) + e_2 \sin(2\,pt + \alpha_2) + \;.\;.$$
$$+ e_n \sin(n\,pt + \alpha_n)$$
$$i = i_1 \sin(pt + \beta_1) + i_2 \sin(2\,pt + \beta_2) + \;.\;.\;.$$
$$+ i_n \sin(n\,pt + \beta_n)$$

and $p = 2\pi \times$ frequency of the fundamental. AUTHOR.

123. *Graphical Study of Alternate Currents.* **C. E. Guye.** (Écl. Électr. 16. pp. 397–405, 1898.) (See 1898 Abstracts, Nos. 524, 796, and 1162.)—The author concludes his series of articles by considering the graphical solution of problems relating to: (1) circuits containing resistance, inductance, and capacity, but without mutual inductance; (2) ditto with mutual inductance; (3) circuits containing several impressed E.M.F.'s. The treatment is very systematic, the author in each case giving—(*a*) a diagram of the circuit; (*b*) the equations relating to it; (*c*) the vector diagram containing the solution of the problem. A. H.

124. *Alternating Currents in Branching Circuits.* **H. T. Eddy.** (Amer. Instit. Elect. Engin. 15. pp. 511–554, 1898.)—When an alternating potential difference E sin pt of frequency n is applied between the terminals of a circuit of resistance R and self-induction L, the current i is given by

$$i = \frac{E \sin(pt - \delta)}{\sqrt{R^2 + p^2 L^2}}$$

Where $\tan \delta = \frac{pL}{R}$

This can be written

$$i=\frac{E}{R}\cdot\frac{\sin(pt-\delta)}{\sqrt{1+\tan^2\delta}}$$

$$=\frac{E\cos\delta}{R}\cdot\sin(pt-\delta)$$

If the circuit contains a capacity C instead of self-induction the current is given by

$$i=\frac{E}{R}\cos\phi\sin(pt+\phi)$$

where

$$\tan\phi=\frac{1}{pCR}$$

If R is kept constant while δ and ϕ are varied, the loci of the extremities of the current vector will be semi-circles having diameters equal to $\frac{E}{R}$.

The author regards $\tan\delta$ and $\tan\phi$ as a kind of co-ordinates and thereby investigates graphically the properties of split circuits. Series of semicircles are drawn for different values of $\tan\delta$ and $\tan\phi$ from *o* to infinity, and their points of intersection give the position of the currect vector for the value of these co-ordinates given by their intersection. W. G. R.

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125. *Rectification of Alternating Currents.* **P. Janet.** (Comptes Rendus, 126. pp. 1785–1788, 1898.)—The author discusses the problem: Given a Gramme ring provided with a collector and two brushes, but without inductors; two diametrically opposite points of the ring are fed from an alternating source of frequency *n*, and of constant effective value; the ring being brought into synchronism by means of an auxiliary motor, what will be the nature of the supply at the brushes? G. B. M.

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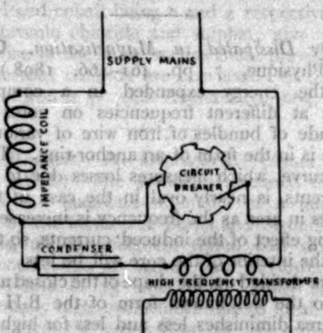
126. *Tesla's Circuit Interrupters.* (Elect. World, 32. pp. 181–184, 1898.)—A fully illustrated description of the devices recently patented by Tesla for producing rapidly oscillating currents. The arrangement of connections used with these interrupters is shown in the accompanying sketch. The interrupters are suitable for use on either direct or alternating current circuits, and have been designed with a view to the highest possible efficiency. The interrupter is in all cases driven by a motor, and the make and break take place either between mercury and a solid conducting terminal, or else between two jets of

mercury. One example of the first type consists of a hollow cylindrical vessel mounted on a horizontal axis, and containing some mercury and oil. This is driven at a very high speed, the liquids being carried round and forming two rings, an outer one of mercury and an inner one of oil. A small star-wheel (whose axis is fixed) is driven round by the rotating liquid rings, the teeth of the wheel alternately dipping into and being withdrawn from the mercury, while the arcs are extinguished by the oil. A very high make-and-break frequency is thereby attainable. In the other devices described, the main object has been to minimise the waste of energy due to sparking. This is accomplished by introducing, in various ways, into the break chamber, fluids (*e.g.*, anhydrous ammonia) under great pressure. The spark is thereby said to be prevented from spreading laterally, and to be quickly extinguished. A. H.



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127. *Alternating Current Curve Tracer.* **H. L. Callendar.** (Electrician, 41. pp. 582–586, 1898.)—A descriptive account of an instrument for tracing automatically a continuous pen-and-ink curve representing the cyclical variation of the quantity to be recorded. The apparatus consists essentially of a recording potentiometer working in conjunction with an instantaneous contact-maker driven by a synchronous motor. A number of sample curves are given exhibiting the capabilities of the instrument. A. H.

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128. *Hysteresis at High Frequencies.* **I. Klemenčič.** (Wien. Akad. Sitzber. 107. pp. 330–360, 1898.)—By passing the oscillatory discharge from a condenser through magnetising

coils which enclose iron, and observing the decrement of the discharge by intermittent contacts, the author proves that with iron possessing a low coercive force (up to 5 or 6), the hysteresis loss per cycle is distinctly greater with high frequencies than with low. The approximate formula employed gives too low a value for the losses, and the author *has no reliance* on the results obtained with specimens of iron possessing a higher coercive force (16), which indicate a diminution in the losses with higher frequencies.
A. Gs.

129. *Energy Dissipated in Magnetisation.* **C. Maurain.** (Journ. de Physique, 7. pp. 461–466, 1898.)—The author investigates the energy expended in a complete cycle of magnetisation at different frequencies on cores of solid iron and cores made of bundles of iron wire of various thicknesses. The iron core is in the form of an anchor-ring. The closed area in the B-H curve, which measures losses due to hysteresis and Foucault currents, is nearly oval in the case of the solid core, and diminishes in area as the frequency is increased; this is due to the shielding effect of the induced currents, so that the energy dissipated in the interior of the core will be less. As the core is more and more divided up, the shape of the closed area approaches more nearly to the well-known form of the B-H curve for soft iron, and its area diminishes less and less for higher frequencies. In the case of the smallest sub-division of the core, the wires of which it is composed being 0·2 mm., the shape is that of the well-known form and the area is practically the same between frequencies of 23·65 and 55. In all the curves obtained the author found that the maximum of the induction lagged behind that of the current; this lag is greater the less divided the core, a fact easily explained by the action of the induced currents. The lag appears, however, in the case of the most divided core, and the author regards it as a true lag of the magnetisation behind the exciting field, independent of the action of the induced currents.
E. C. R.

130. *Magnetic Screening.* **C. Maurain.** (Écl. Électr. 15. pp. 177–179, 1898.) (Compare Abstract No. 793, 1898.)—The theory of the action of electromagnetic screens made of magnetic materials is complicated by the variation of the magnetic permeability with the intensity of the field. The behaviour of such screens is, however, in general terms as follows: A screen of magnetic material will have a greater effect than a non-magnetic screen of equal conductivity. The frequency of alternation remaining constant, the effect will at first increase with the intensity of the field; after passing the point at which the permeability of the screen is a maximum, the action will again diminish. The author's experiments, made in the way previously

described, show these deductions to be correct. The screening action also increases as the frequency of alternation of the current increases. T. E.

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131. *Magnetic Susceptibility of Liquids.* **G. Jäger and S. Meyer.** (Wien. Akad. Sitzber. 107. pp. 5–13, 1898.) Further experiments are made in order to determine whether the atomic susceptibility of chromium in solutions of its salts is exactly 3, those of nickel and cobalt being 2 and 4 respectively. Measurements with chromic chloride and sulphate give 2·5. The salts behave otherwise in the same way as those previously examined. Solutions of ferrous chloride are also used; in them the atomic susceptibility of iron is 3. (Cf. Abstract No. 664, 1898.) T. E.

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132. *Aged Magnets.* **A. Durward.** (Amer. Journ. Sci. 5. pp. 245–256, 1898.)—The author determined the temperature coefficients of the magnetic moments of a large number of magnets aged by the method of Barus and Strouhal. With very few exceptions, all the magnets tested had distinctly greater temperature coefficients at higher than at lower temperatures, between the limits of 15° and 100°. Many of the magnets showed abnormally high coefficients due to local softness. The following table gives the length L in cm., the outside diameter D and the inside diameter *d* in cm., and the mean loss *m* of the magnetic moment per degree Centigrade, for tubular magnets of crescent polished drill rod—

L	D	*d*	*m*
6	0·95	0·70	0·00087
7	0·95	0·70	0·00075
7·5	1·28	0·94	0·00063
10	1·28	0·94	0·00061

E. E. F.

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133. *Constancy of Magnetised Bars.* **Mme. Sklodowska-Curie.** (Bull. Soc. d'Encouragement, série 2. t. 3. p. 63, also Écl. Électr. 16. pp. 117–126, 1898.)—The authoress has experimented on—(1) The action of shocks and jars; (2) the action of variations in the surrounding temperature; (3) the action of magnetic fields produced by magnets or neighbouring currents; (4) the effect of time. The paper deals very thoroughly with the above, but does not well admit of an abstract. E. C. R.

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134. *Magnetic Properties of Tempered Steel.* **Mme. Sklodowska-Curie.** (Bull. Soc. d'Encouragement, série 5. t. 3. p. 58, also Écl. Électr. 16. pp. 151–155, 1898.)—The authoress gives the I-H curves of five steels from the steel manufactory of Firminy having increasing percentages of carbon, a carbon steel of Unieux,

Allevard steel, a tungsten steel, a steel with 3 per cent. nickel, a steel with 0·7 per cent. manganese. An examination of the curves shows that the introduction of different metals slightly modifies the residual intensity of magnetisation in a closed magnetic circuit; it augments the coercive field and the hysteresis, and diminishes the maximum intensity of magnetisation induced. The curves were obtained with values of H between ± 500. E. C. R.

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135. *Measurement of the Changes produced in Metals by Magnetisation.* **J. S. Stevens.** (Phys. Rev. 7. pp. 19–26, 1898.)—A slightly modified "interferometer" is employed. The mirror frame, which is commonly attached to the movable bed, is removed and firmly screwed to the end of the iron or steel rod to be tested. The other end of the rod is made fast to a brass cylinder, which can be moved backwards and forwards by a micrometer screw. The magnetising coil surrounding the rod is supported independently. In the preliminary experiments rods 30·5 cms. in length and 0·953 cm. diameter were employed. By the interference method, changes which might occur in a rod other than expansion or contraction may be noted. For example, if the rod is distorted the effect is very clearly seen. If the distortion is the result of horizontal planes slipping past each other in a direction parallel to the length of the rod, the mirror will move as if rotated round a horizontal axis. In this case the fringes, which formerly appeared vertical, become inclined at an angle depending on the amount of the distortion. If the distortion is caused by the slipping of vertical planes, the fringes approach or recede from each other. The first effect was quite noticeable in the case of soft iron, but did not appear in steel or nickel. The second was suspected in several cases, but was more difficult to detect. Aluminium, copper, and brass gave no results that could be detected. Nickel showed a contraction for values of H between 5·5 and 38·5 of $\lambda/4$, iron an expansion of from 0·02 λ to 0·5 λ, λ being the wave-length of sodium light. The experiments were then repeated under more favourable conditions on a soft iron rod. Length of rod 75·5 cms., diameter 0·6 cm. Magnetising coil, length 84·8 cms., external diameter 9 cms., internal diameter 4·7 cms.

H	B	δl	$\delta l/l$
102·5	23173·1	13·37 × 10^{-5} cm.	17·7 × 10^{-7}
41·0	14537·2	6·75	8·9
20·5	10249·1	4·66	6·2
12·8	7813·9	2·42	3·2
9·3	6430·3	1·55	2·1
5·7	5626·1	1·18	1·6
4·7	5210·3	1·11	1·5

E. C. R.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

136. *Molecular Weights of Liquids.* **C. L. Speyers.** (Journ. Phys. Chem. 2. pp. 347–361 and 362–363, 1898.)—The molecular weights of various liquids in mixtures are calculated from the reduction of the vapour pressure of the constituents, observed by Linebarger and Raoult. The results are held to show both association and dissociation. From the equality of vapour pressure of the two phases in equilibrium, of two liquids not miscible in all proportions, a difference in molecular association is inferred. B. B. T.

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137. *Diffusion of Sulphides through Steel.* **E. D. Campbell.** (Indus. and Iron, 25. p. 230, 1898.)—The author, in conjunction with C. Sundström, has repeated his experiments which J. E. Stead had doubted. A hole was drilled in a Bessemer steel bar, filled with a mixture of oxysulphide of iron (containing manganese) and cuprous sulphide, and plugged with steel; the bar was placed on asbestos and heated to a little above 1200° C. for three hours, air having access. Subsequent determinations of the copper in the steel, in the heavy scale forming on it, and in the asbestos prove that the sulphide had diffused through the steel, which retained about 5 per cent. of the total copper, into the scale and chiefly into the asbestos, which contained 87 per cent. of the copper. The diffusion was less complete when air was excluded from the interior of the furnace, in which lumps of charcoal had been placed. The sulphur of the sulphides is apparently burned. The hole should be treated with hydrochloric acid for an hour previous to being charged; if it is left smooth, the diffusion is slight. The temperature must rise above 1200° C. Stead was thus right in assuming that a great deal depended upon the conditions of the experiments.

H. B.

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138. *Solubility of the Carvoximes.* **H. Goldschmidt** and **H. C. Cooper.** (Zeitschr. Phys. Chem. 26. pp. 711–718, 1898.)—In order to test the suggestion that the right- and left-handed modifications of an optically active substance may be unequally soluble in an active solvent, the authors have determined the solubilities of *r*- and *l*-carvoximes in *r*-limonene at different temperatures. The two solubility curves are found to be identical. Again, if the racemic compound of the two carvoximes exists in the liquid state the solubility of the fused mixture of *r*- and *l*- carvoximes should be smaller than that of the pure active modifications. Using a mixture of water and alcohol as solvent no difference in these solubilities could be

detected. In presence of aqueous alcohol the carvoximes melt at a temperature some 20° below their ordinary melting points owing to the solubility of water in the fused substances. T. E.

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139. *Supposed New Atmospheric Gas.* **O. Neovius.** (Wied. Annalen, 66. 1. pp. 162–169, 1898.)—After eliminating all spectrum lines due to electrode matter, the author catalogued the lines due to nitrogen and argon as they appear at atmospheric pressure. He then found some fifteen lines which were common to the blue argon spectrum and to the nitrogen spectrum, the brightest of them being at 4379, 4401, 4430, 4545, and 4736. They are somewhat fainter in the nitrogen spectrum. The author supposes that they are due to an unknown gas which remains as an impurity in the preparation of argon, and also, but to a lesser extent, in the preparation of nitrogen. The spectrum of the supposed new element shows a single coincidence with that of crypton at 4736. E. E. F.

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140. *Physical Effects of Light.* **M. Roloff.** (Zeitschr. Phys. Chem. 26. 2. pp. 337–361, 1898.)—The physical effects of light may be classified under the two heads of modification of the order of the atoms in the molecule, and of the mutual position of the molecules. The former is noticed in various acids, where forms like malic acid are converted into the corresponding forms, such as fumaric acid, under the influence of light. In these changes the two halves of the molecule, connected by a double link, are turned through an angle of 180° with respect to each other. The original form is always the more easily soluble, and has the lower melting and boiling points. As regards polymerisation, it may be said that light produces new combinations between the molecules wherever double links exist. The colourations of salts by kathode rays are intimately associated with the phosphorescence phenomena of fluorspar, calcspar, and other minerals. E. E. F.

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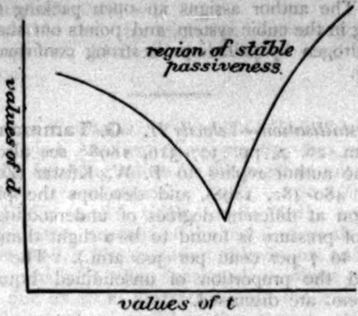
141. *Passive State of Iron and Steel.* **L. Houllevigue.** (Journ. de Physique, 7. pp. 468–469, 1898.)—When iron and steel, previously rendered passive by concentrated acid, is plunged into nitric acid of density *d*, there exists a certain temperature *t*, on one side of which the passiveness is stable, while on the other it is unstable, that is to say it can be destroyed by the contact of a copper wire or the passage of an electric current; *t* may be called the critical temperature. Plotting values of *d* as ordinates, and *t* as abscissæ, a curve is obtained which is

characteristic of the kind of iron or steel used. The form of curve is as follows :—



It is seen that for the same density there are two temperatures such that the passive state is only stable between them. The reaction, at the higher temperature at which the passive state ceases, gives, throughout the liquid, rutilant vapours, while the bubbles which are formed at the lower temperature at the contact between metal and liquid are colourless, and are doubtless monoxide or dioxide of nitrogen. E. C. R.

142. *Vapour Pressures of Hydrated Salts.* **W. Müller-Erzbach.** (Wien. Akad. Sitzber. 107. pp. 14–19, 1898.)—Small quantities of the salt are exposed, at constant temperature, to an atmosphere saturated with water vapour given off by mixtures of sulphuric acid and water of known vapour pressure. The samples are weighed at intervals of a day. In this way an acid is readily found in presence of which the salt does not change in weight. The vapour pressure of the salt may be determined in this way with an error of less than 1/50 mm. of mercury. The experimental work was carried out with Glauber's salt at the ordinary temperature. T. E.

143. *Freezing-Points of Dilute Solutions.* **C. Dieterrici.** (Wied. Annalen, 64. 4. pp. 809–810, 1898.)—A reply to R. Abegg's criticism. Annal. Phys. Chem. 64. p. 486–506, 1898, of author's paper, Annal. Phys. Chem. 62. p. 616–643 (1897). B. B. T.

144. *Structure of Crystals.* **W. J. Sollas.** (Roy. Soc. Proc. 63. pp. 270–300, 1898.)—This paper consists of a study of the molecular tactics of crystals of the cubic system with cubic cleavage. The author assigns an open packing to the metals crystallising in the cubic system, and points out that the absorption of hydrogen by palladium is strong confirmatory evidence of this view. S. R.

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145. *Crystallisation—Velocity II.* **G. Tammann.** (Zeitschr. Phys. Chem. 26. 2. pp. 307–316, 1898; see also 23. p. 326, 1897.)—The author replies to F. W. Küster (Zeitschr. Phys. Chem. 25. 480–482, 1898), and develops the phenomena of crystallisation at different degrees of undercooling more fully. The effect of pressure is found to be a slight diminution of the velocity (4 to 7 per cent. per 300 atm.). The behaviour of crystals and the proportion of unsolidified liquid remaining between them, are discussed. B. B. T.

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146. *Chemical Applications of the Electric Arc.* **Bredig.** (Zeitschr. Elektrochem. 4. pp. 514–515, 1898.)—By means of the electric discharge between carbon points under petroleum an illuminating gas is produced which contains 30 per cent. of heavy carburetted hydrogen, and 6–8 per cent. acetylene. If an electric arc is made from metal wires under pure water, the wires of zinc, silver, platinum, &c., are pulverised into an extremely fine suspension of those metals in water. So that obscure liquids are produced, which, especially in the case of the noble metals, go through the filter coloured, and in particular in the case of platinum often do not become clear for weeks. Tichomiroff and Lidoff have already described this pulverisation in the case of zinc. They conclude that the metallic vapours of the arc in the surrounding cold water immediately become condensed as mist, and through instantaneous chilling remain kept from uniting together. Thus very finely divided platinum which exhibits catalytic action, can be produced from platinum wire with the help of the arc without a chemical reducing medium. J. J. S.

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147. *Migration Constant of Hydrogen.* **D. McIntosh.** (Journ. Phys. Chem., 2. pp. 273–288, 1898.)—The migration constant of an ion can be obtained either by Hittorf's direct method of analysis, or by Helmholtz's method from observations on the E.M.F. of a concentration cell. The author seeks to apply Helmholtz's method to Grove's gas cell. He uses hydrogen over different concentrations of various acids arranged for diffusion and without diffusion. Chlorine, bromine, and iodine cells are also investigated.

The general conclusions are:—

1. The Helmholtz method is not applicable to gas cells.

2. The source of error is probably in the solubility of the electrode (platinised platinum).

3. It is probable that the migration constant for hydrogen does not change with dilution between normal and thousandth-normal solutions. S. S.

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148. *Migration Constants for Zinc and Cadmium Salts.* **G. Kümmell.** (Wied. Annalen, 64. 4. pp. 655–679, 1898.)—The author finds the following values for the negative ion in dilutions from 1/100 to 1/400 normal. $ZnCl_2$ 0·60: $ZnBr_2$ 0·60: ZnI_2 0·59: $CdCl_2$ 0·58: $CdBr_2$ 0·58: CdI_2 0·55. These salts give quantitative deposits of the metal when air is excluded and pure water used. The evolution of hydrogen and separation of hydroxide, which is often observed in dilute solutions, is shown to be due to alkali abstracted from the glass; but even here the total amount of metal in the deposit and hydroxide obeys Faraday's law. The values for $ZnCl_2$ and $CdCl_2$ agree with those determined indirectly from the E.M.F. of the combinations—

$$M - MCl_2\ 0{\cdot}1 \text{ normal} - M\,Cl_2\ 0{\cdot}01 \text{ normal} - M$$

and—

$$Hg - HgCl - MCl_2\ 0{\cdot}1 \text{ normal} - MCl_2\ 0{\cdot}01 \text{ normal} - HgCl - Hg$$

of which the first is proportional to n, the second to $(1-n)$. Comparison of the conductivity at infinite dilution $(\lambda_\infty = u+v)$ calculated from the above on the assumption that the mobility of the negative ions is the same as in their alkali salts, with that directly observed, shows that except in the case of CdI_2 the limiting transportation values have probably been reached.

In the electrolysis of the sulphates a flocculent deposit is always observed, and Faraday's law is not obeyed. This is due to a secondary action of the salt on the metal forming basic sulphate. When the amount of SO_4 in the precipitate is determined, and the corresponding amount of metal deducted, the total electrolytic deposit is found to satisfy the law. For $CdSO_4$, the author finds $n = 0{\cdot}62$ agreeing with the value from the concentration cells, but for $ZnSO_4$ 0·66 differing greatly from the indirectly determined value 0·59: this probably indicates the existence of complex ions as $\overline{Zn}(\overline{SO_4})_2$. The calculated conductivity for infinite dilution also does not agree with the observed value. B. B. T.

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149. *Ionisation determined by means of Conductivity.* **A. A. Noyes.** (Zeitschr. Phys. Chem. 26. pp. 699–710, 1898.)—The heat of solution of a salt dissociating into two ions in accordance

with the dilution formula of Rudolphi and van't Hoff is given by van Laar as $q=\mathrm{RT}^2\, 3/(3-\alpha)\,\frac{d \log s}{d\,\mathrm{T}}$, where s is the solubility and α the degree of dissociation. Independently of any dilution law, the value for $\alpha=1$ must be $q=2\mathrm{RT}^2\, d \log s/d\mathrm{T}$, which does not agree with van Laar's equation. By means of a reversible cycle, the following equation (first given by van't Hoff) is deduced; $q=\mathrm{RT}^2\, i\, d \log i\, s/d\mathrm{T}$. For an electrolyte dissociating into n ions and following a dilution law of the form $\mathrm{K}=(\alpha s)^{\gamma}/(1-\alpha)\,s$. This gives—

$$q = \mathrm{RT}^2\left(\frac{\gamma+(n-\gamma)\alpha}{\gamma-(\gamma-1)\alpha}\,\frac{d \log s}{d\,\mathrm{T}}+\frac{(n-1)\,\alpha\,(1-\alpha)}{\gamma-(\gamma-1)\,\alpha}\,\frac{d \log \mathrm{K}}{d\,\mathrm{T}}\right).$$

When α is approximately unity (salts), or zero (weak acids and bases), the second term tends to vanish. Neglecting it we obtain for $\gamma=2$ and $n=2$ (Ostwald's dilution law) $q=\mathrm{RT}^2\; 2/2-\alpha\; d \log s/d\mathrm{T}$ . . . (1), and for $\gamma=3/2$ and $n=2$ (van't Hoff's dilution law) $q=\mathrm{RT}^2\,(3+\alpha)\,(3-\alpha)\,d \log s/d\mathrm{T}$ . . . (2). The values of q calculated from equation (1) for a weak acid and from (2) for some salts agree very well with those experimentally obtained. Van Laar's equation gives wide divergence to explain which he assumed that the values for the dissociation obtained from the conductivity are incorrect. He supported this view by the fact that solutions of hydrochloric acid in aqueous alcohol and in water, equally dissociated according to conductivity measurements, invert cane sugar with different velocities. This is, however, due to the different concentrations of the water. His hypothesis that the dissociation is affected by the heating effect of the current used in measuring it is not compatible with the fact that the conductivity is independent of the strength of current. Finally, dissociations measured by freezing-point experiments, and by solubilities of mixtures of salts, agree well with those measured electrically. T. E.

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150. *Electrolytic Preparation of Glucinum.* **P. Lebeau.** (Comptes Rendus, 126. pp. 744–746, 1898.)—Glucinum may be obtained in a pure state by the electrolysis of the double fluoride of glucinum and sodium which is a conductor. The process was carried out in a nickel crucible which served as negative electrode, the positive one being a plate of graphitic charcoal. The metal was obtained in the form of a powder consisting of irregular crystals of pure glucinum. Under the microscope it is a brilliant metallic white colour, and contains no trace of amorphous matter. J. J. S.

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151. *Electrolysis of Zinc Chloride Solutions: the Nature of Zinc Sponge.* **F. Foerster** and **O. Günther.** (Zeitschr. Elektrochem. 5. pp. 16–23, 1898.)—Experiments were made on the electrolysis of zinc chloride solutions, from which cadmium and other more electronegative metals had been removed by precipitation with metallic zinc, and the neutrality, acidity or alkalinity of which was carefully controlled by analysis. The anodes consisted of electrolytic zinc, containing traces only of lead and iron, and the kathodes of ordinary zinc plate. The solutions were kept in continual agitation by a mechanical stirrer. In the case of neutral solutions, a deposit of fine, smooth zinc was first obtained, but sooner or later a spongy mass was formed, and the solution became turbid from precipitation of basic zinc chloride. This was not prevented by the action of chlorine produced electrolytically in the solution by a current of 0·1 to 0·2 ampere between platinum anodes and the kathode of the principal current. Excellent results were obtained, however, in solutions acidified with hydrochloric acid to 1/20–1/30 of the normal strength, together with the slow and continuous liberation of chlorine as above described. Instead of chlorine, a current of air may be employed, but in that case, owing to the rapid oxidation of the zinc, the free acid in the solution is more quickly neutralised, and fresh additions have frequently to be made. It was to be expected that the electrodeposition of zinc might be effected in alkaline solutions, if only the solubility of zinc oxide therein could be sufficiently increased by raising the temperature and the concentration. This was found to be the case; electrolysis at 60° gave unsatisfactory results, but fine crystalline deposits were obtained at 90–100° with 40 per cent. solutions of zinc chloride saturated with zinc oxide. It has been stated by Ashcroft that in the electrolysis of such hot alkaline solutions, using insoluble anodes, a far greater amount of zinc was deposited than that accounted for by Faraday's law. A number of experiments made with a copper voltameter included in the circuit were not confirmatory of this statement, the metal deposited being always somewhat less than the theoretical amount. The deficiency is attributed to secondary reactions, the chlorine liberated at the anode reacting with the zinc oxide to form zinc hypochlorite which then suffers reduction at the kathode.

The observations of the authors are in harmony with the received opinion that the spongy deposit of zinc is formed in neutral or slightly alkaline solutions, when the hydrogen ions are liberated in such quantity that the simultaneous concentration of hydroxyl ions in the region of the kathode lead to the formation of zinc hydroxide or basic zinc salts. The formation of the sponge is favoured, as might be expected, (1) by too dilute solutions, (2) by the presence of metals more electronegative than zinc, (3) by gas-bubbles on the kathode, which hinder diffusion of the liquid and cause an irregular deposition of metal. The concentration of hydroxyl ions and the consequent production of sponge is effectually prevented by the presence of free acids. It is to be observed that the acidity of the liquid in the immediate vicinity of the kathode is the essential condition to be fulfilled; hence the need of continual renewal of the liquid at this point by constant agitation. Neutral oxidising agents favour the production of spongy zinc so long as they do not increase the concentration of the hydrogen ions; otherwise they hinder it. To the first class of substances belong hydrogen peroxide and ammonium nitrate; to the second, chlorine and ammonium persulphate. Potassium permanganate is an effectual preventative in neutral solution, although its action leads to the production of hydroxyl ions; its efficiency is due, however, to the carrying down of zinc oxide with the precipitated manganese peroxide. J. W.

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152. *Electrolytic determination of Tin in Tin Ores.* **E. D. Campbell** and **E. C. Champion.** (Indus. and Iron, 25. pp. 267–268, 1898.)—A description of a modified form of Classen's double oxalate method. One gramme of the finely ground ore is intimately mixed with 5–6 grms. of the sodium carbonate and sulphur fusing mixture, and is fused at a full red heat for one hour. The porcelain crucible containing the ore is placed within a large one to lessen risk of oxidation, and this again is covered by an inverted Hessian crucible during fusion in order to obtain uniform heating.

After cooling, the soluble tin salt is dissolved out by treating with 40–50 c.c. of hot water; the residue is washed, dried, ignited, and again fused with the mixture in the same crucible, in order to extract the last traces of the tin. Hydrochloric acid is added to the united solutions till slightly acid, and stannic sulphide is precipitated; and the solution is boiled down to drive off sulphuretted hydrogen and to reduce its volume to between 75 and 80 c.c. Ten ccms. hydrochloric acid (1·20 sp. gr.) are now added to the hot solution, and from 2–3 grammes sodium peroxide are added little by little until the tin has been wholly converted into stannic chloride. The solution is now boiled again to cause the sulphur to collect, and it is then filtered into a platinum dish. Ammonium hydrate is added until a slight permanent precipitate has formed, and then 50 c.c. of a 10 per cent. solution of acid ammonium oxalate. The solution should now be clear. It is electrolysed with a current of ·10 ampere at 4 volts, and may be left overnight for deposition of the tin. The latter will be found as a white metallic deposit, firmly adherent to the platinum dish. The determination is completed in the usual manner. The authors recommend the carrying out of dual determinations under precisely similar conditions, and the use of a platinum dish as counterpoise in weighing.

J. B. C. K.

153. *Electrolytic Indigo-Vats.* **A. Binz.** (Zeitschr. Elektrochem. 5. pp. 5–9, 1898.)—The reduction of indigo-blue to indigo-white is in practice effected by zinc dust in presence of caustic soda, the reaction taking place easily at the ordinary temperature. Attempts to effect the reduction by means of the hydrogen evolved at the kathode in the electrolysis of caustic soda solution have shown that the reaction is very incomplete unless the liquid is raised to the boiling temperature, and that if the action of the current be too long continued the indigo-white is destroyed and rendered useless. In the course of an investigation of the most favourable proportions of zinc and alkali for the reduction of indigo, the author found that a solution of caustic soda, so dilute as to have scarcely any action on zinc, was yet sufficiently effective to take part in the reduction of a considerable quantity of indigo. It was found, moreover, that when a zinc anode and platinum kathode were placed in two vessels, filled with alkaline indigo solution, connected by a syphon, and joined up in circuit with a battery and a copper voltameter, that reduction took place at the anode, where no hydrogen could be evolved, and that the loss in weight of the zinc anode was greater than that corresponding with the copper deposited in the voltameter. The zinc in this experiment was amalgamated, and in the absence of indigo, it was found that the loss in weight of the zinc was strictly in accordance with Faraday's law. It would appear, therefore, that the reduction of the indigo is brought about by direct action of the zinc, and not by the hydrogen evolved by the action of the metal on the alkali. The latter serves the purpose of keeping in solution the zinc oxide which, if the alkali is too dilute, encrusts the anode and prevents further action. J. W.

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154. *Formation of Indigo-white by Galvanically Deposited Zinc.* **A. Binz.** (Zeitschr. Elektrochem. 5. pp. 103–108, 1898.)—This paper deals with the reduction of indigo-blue to indigo-white by means of an alkaline zinc bath and the application of the current. The author shows that electrolytic hydrogen has only a very slight and incomplete action upon indigo-blue, but that zinc deposited by the current brings about an almost theoretical conversion. A series of experiments are here given which prove that the zinc deposited converted fifteen times as much blue into white as the equivalent of hydrogen set free by the same current. O. J. S.

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155. *Siemens and Halske Process in the Transvaal.* **H. Pauli.** (Zeitschr. Elektrochem. 5. pp. 101–103, 1898.)—This paper is an historical account of the development and growth of the Siemens-Halske electrolytic cyanide gold extraction process. The author gives some thirty mines where the Siemens process is at work,

and states that in the case of poor solution it is superior to the original MacArthur, and it also has the further advantage that the gold bullion is free from zinc. The royalty charged is 2 per cent. O. J. S.

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156. *Regenerative Electro-Zincing.* (Indus. and Iron, 25. pp. 268–269, 1898.)—This paper gives a short illustrated description of the Cowper-Coles process of electrogalvanising Belleville boiler tubes both inside and outside. It describes the method of regenerating the zinc sulphate solution by means of zinc dust, and includes sectional drawings showing the disposition of the plant. J. L. F. V.

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157. *Calcium Carbide Works at Ingleton.* **F. J. A. Matthews.** (Electrician, 41. pp. 643–645, 1898.)—This paper gives an outline of the latest practice in the manufacture of calcium carbide under Raoul Pictet's patents as illustrated by their first practical application in England. The principle of gradually raising the temperature of the lime and coke mixture by means of the waste heat from the zone of the electric arc is explained, and the furnace is described and illustrated. The novel features of the 120-kilowatt dynamo, which enable it to run with great variation of load, are pointed out.

The carbide made in this furnace yields an average of 5 cubic feet of gas per lb. J. L. F. V.

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158. *Electric Smelting.* **W. S. Horry.** (Elect. World, 31. pp. 784–785, 1898.)—From a sulphide nickel ore containing about 42 per cent. of sulphur combined with iron, nickel and silica, the author obtained by electric smelting a charge containing 40 per cent. nickel, 28 per cent. iron, 12 per cent. carbon, 15 per cent. silicious matter and no sulphur. Nickel in a fair state of purity can be obtained by this process, but as yet no data as to cost are available. E. H. C.-H.

GENERAL ELECTRICAL ENGINEERING.

159. *Accumulator Charging at Constant Pressure and at Constant Current.* **A. A. Cahen** and **J. M. Donaldson.** (Electrician, 41. pp. 674–677 and 710–712, 1898.)—The experiments described in this paper were made with a single 5-plate Tudor cell, formed positives and pasted negatives, listed to give a discharge of 36 amperes for 3 hours and for a normal charging rate of 20 amperes. In the constant potential series of tests the cell was charged at 2·508 volts and the charge continued until the current had dropped to 10 amperes. At starting, the current was as much as 160 to 170 amperes but fell rapidly. In the constant current series the charging current was 20 amperes throughout, until the potential difference had risen to 2·58 volts. In both cases the cell was discharged at 36 amperes until its potential had fallen to 1·815 volts. The variations of current, E.M.F., and specific gravity of the electrolyte during charge and discharge are fully illustrated by curves. The comparison of the results obtained by the two methods showed that at constant potential the cell could be charged in less than half the time and its capacity was about 30 per cent. greater, but on the other hand its ampere-hour efficiency was about 2 per cent. less, and its watt-hour efficiency about 10 per cent. less. As far as the experiments went no conclusions could be drawn as to the relative effects of the two methods of treatment on the life of the cell. E. J. W.

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160. *Ammonium-Chloride Accumulator with Carbon Plates.* **W. M. Stine.** (Amer. Electn. 10. pp. 418–419, 1898.)—This is an account of some experiments made with the above combination in 1891. The storage largely depends on the absorption by the electrodes of the gases liberated on charging, and the best effect was obtained with granular arc-light carbon packed round the plates. The author concludes that although the cell is light and inexpensive to construct it has no commercial value on account of (1) the rapid deterioration of the positive plate, *i.e.*, the anode; (2) the rapid loss of charge on standing; (3) the rapid fall of E.M.F. on discharge, and—(4) the low efficiency.

E. J. W.

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161. *Accumulator Construction.* **D. Fitz-Gerald.** (Elect. Eng. 21. pp. 553–554, 593–594, and 22. pp. 11–13, 70–71, 102–103, 198, and 294–295, 1898.) — Continuation of articles on this subject. EDITOR.

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162. *Solder for Aluminium.* (Électricien, 15. pp. 389–391, 1898.)—A good solder for aluminium is here stated to be an alloy

composed of 70 parts of aluminium, 20 of tin and 10 of copper. This alloy gives perfect and solid joints without any galvanic action. The best flux to use is potassium fluoride. W. G. R.

163. *Lithin.* (Elektrochem. Zeitschr. 5. pp. 105–106, 1898.)—"Lithin" is the name of a new insulating material, intended as a substitute for ebonite or vulcanised fibre. Sheets of lithin submerged in water for 72 hours, increased in weight by only 0·41 per cent. Tests are given of the dielectric-resistance of various samples, but the details are too few to enable comparisons to be drawn. When connected to the terminals of a transformer, a plate 1·25 mm. thick broke down at 9,300 volts; a plate 10·5 mm. thick withstood 36,000 volts. The Reichanstalt is examining the material. R.A.

164. *Relative cost of Copper, Aluminium, and Iron as Conductors.* **J. B. C. Kershaw.** (Elect. Rev. 43. p. 331, 1898.)—The writer gives a formula for use in calculating the relative costs of equal lengths of conductors of equal electrical resistance, and then applies it to the calculation of the relative costs of the three metals named above.

Using S for the specific gravity, P for the cost price per lb. and C for the conductivity of copper, and $s\ p\ c$ for the corresponding values of the other metal, the formula

$$\frac{S \times P \times c}{s \times p \times C}$$

will be found to give the relative costs of the two metals when used as conductors. Substituting the numerical values for the symbols S P C and $s\ p\ c$, the following ratios are obtained:—

Copper	:	Aluminium[1]	101	: 100
Copper	:	Aluminium[2]	100	: 135
Copper	:	Iron	278	: 100

Calculating these ratios upon Iron = 100, the following table is obtained—

Iron	100
Aluminium[1]	275
Copper	278
Aluminium[2]	375

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[1] A. E. Hunt's price for 100 per cent. aluminium in bar form; 29 cents per lb.

[2] Market price for 99 per cent. aluminium in ingot form; 31·7 cents per lb.

AUTHOR.

165. *Wiring Chart.* **R. L. Ellis.** (Elect. World, 31. p. 778, 1898.)—This chart is designed with the object of graphically calculating feeders and service wires, and lessening the labour entailed; it can be easily used and can be readily constructed to suit the varying conditions occurring in practice.

In any system the lamps are usually all of one efficiency, so that for a given case the current per lamp is a constant. This leaves four variables: loss in volts, number of lamps, distance and cross section. A different chart has to be constructed for lamps of different current consumption. An illustration is given of the above chart where the horizontal scale is marked out in convenient divisions, say up to 200 feet, and the vertical scale to a convenient scale such as 10 volts. Then the drop is calculated for different sizes of wire, say, from No. 2 to No. 14. By drawing suitable diagonals a chart is obtained useful for a given number of lamps at a given efficiency with a variable "drop" and for various sizes of wire. The chart can also be arranged for a variable number of lamps.

L. J. S.

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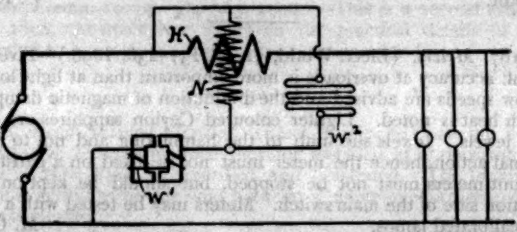
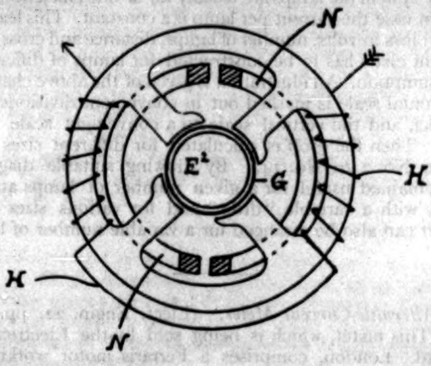
166. *Alternate-Current Meter.* (Elect. Engin. 22. pp. 82–83, 1898.)—This meter, which is being sold by the Electrical Company, Ltd., London, comprises a Ferraris motor working with single-phase alternating-current. The field magnet is made with four similar pole-pieces each having an extension on one side. The series-winding H is of the Gramme type; the shunt-winding N is laid in frames inside the poles, the shunt-current being controlled by an inductive resistance W^1 in series therewith. The armature is formed of a bell-shaped piece of copper G revolving over a fixed core E_2, and is arranged so that part of its weight is counteracted by the alternating field. It acts against a Foucault brake disc rotating between permanent magnets. The motion of the armature or rotor arbor is transmitted to the counting train by means of a worm and worm-wheel. To make the meter sensitive under a very light load, the armature is adjusted so that it tends to just rotate continuously by the action of the shunt. To prevent the meter from running idle in this manner, a small piece



of iron wire is attached to the brake disc so as to be attracted by the permanent magnets, and is so bent that the meter remains motionless so long as no main current passes through, nevertheless the slightest action of the main current serves to start it; after being switched out of circuit the rotating portion completes one more revolution until arrested by the action of the permanent magnets on the piece of iron. To measure accurately in inductive circuits, it is necessary that the artificial difference of phase shall amount to exactly 90°. This lag is obtained by arranging a non-inductive resistance W_2 in parallel with the shunt winding of the motor. C. K. F.



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167. *Meters.* (Elect. World, 32. pp. 237–238, 1898.)—Five per cent. accuracy at overloads is more important than at light loads. Slow speeds are advised and the diminution of magnetic damping with heat is noted. Lighter coloured Ceylon sapphires are best for jewels. Jewels succumb to the hammering and not to rotational action, hence the meter must not be fixed on a partition. Shunt meters must not be stopped, but should be kept on the station side of the main switch. Meters may be tested with a box of calibrated lamps. M. O'G.

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168. *Meters.* **H. Armagnat.** (Écl. Électr. 16. pp. 89-93 and 136–139, 1898.)—A number of meters are described. EDITOR.

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169. *Manufacture of Carbons.* **F. Jehl.** (Electrician, 41. pp. 50–52, 177–179, 386–388, 416–419, 580–582, 612–615, and 806–808, 1898.)—A series of articles on this subject. EDITOR.

170. *Standard Threads and Gauges for Screw-Socket Lampholders.* **R. Hundhausen.** (Zeitschr. Elektrotechn. Wien, 16. pp. 334–339, 1898; see also E. T. Z., Berlin, Heft 20 and 22.) —The Verband Deutscher Elektrotechniker have carefully considered the question of fixing a standard thread for screw-socket lamp-holders and lamp-caps, and in the two articles referred to above, are given specifications and drawings of the threads on the lamp and in the socket, and also of gauges for examining caps and sockets made in accordance with such standards. In fixing the standards, both German and American practice have been taken into consideration. C. K. F.

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171. *Electrical Heating Apparatus.* **R. B. Ritter.** (Écl. Électr. 16. pp. 450–453, 1898.)—This article describes the various types of electrical heating apparatus for use on alternating current circuits, and mentions that the *Société d'Electricité Alioth* of Bâle have produced such apparatus in which the heat is developed chiefly by eddy currents in large masses of metal so that the conductors carrying current do not get overheated. W. G. R.

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172. *Underground Mains.* **F. Jehl.** (Amer. Electn. 10. pp. 254–261, 1898.)—Descriptive of systems used in Europe.

EDITOR.

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173. *Erection of High-Pressure Lines.* **S. H. Dailey.** (Amer. Electn. 10. pp. 384–385, 1898.)—This is a second article (see 1898, Abstract No. 1095) on the practical details to be attended to in erecting a high voltage transmission line.

W. G. R.

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174. *Reno Inclined Elevator.* (Elect. Engin. N.Y. 26. pp. 1–3, 1898.)—An electric inclined elevator installed at a department store in New York is described and illustrated. The inclined elevator is said to fill the void between a common staircase and a vertical elevator.

Since it has been installed, 50,000 persons have taken advantage of this novel device without any accident. It is 3½ feet in width and is built at an angle of 25 degrees. The moving incline consists of an endless chain rotated by a sprocket wheel to which are attached a number of hard wood slats. These slats have attached to them a series of rubber-covered ridges, each about 3/4″ wide and 1″ high. These ensure a safe landing at the upper end of the machine.

The general and detailed construction of the elevator is shown in illustrations and diagrams. The elevator is geared to a motor by double reduction gearing, giving a total reduction of 1/36th. The speed of the motor, 450 r.p.m., is thus reduced to about 12 r.p.m. at the chain, which gives the moving incline a speed of 75 feet per minute. The elevator is fitted with a 10 H.P. motor, although the maximum load on the elevator only requires a motor of one-half that capacity. The motor is controlled by an automatic starting box. To the switch of this starting box is attached a cord which leads to the upper and lower ends of the elevator, and by means of which the motor can be started, stopped, or reversed. Another essential feature of the elevator is a moving handrail, travelling at the same speed as the platform.

The elevator, if run continuously for ten hours, will cover about nine miles in one day; and counting one passenger for every two feet, it will carry thirty-seven in one minute, or 2,200 in one hour.

The following table arrived at from a long series of tests, shows the power required for working such an elevator :—

Volts.	Amp.	H.P.	Remarks.
110	8·2	1·2	Elevator free
110	16·0	2·36	5 people on elevator
110	19·0	2·8	9 „ 5′ apart
110	20·0	2·95	11 „ 4′ „
110	35·0	5·15	21 „ 2′ „

Assuming the power to cost 3 cents per H.P. hour it would cost 7 cents to carry 1,000 passengers in one hour.

Among a number of advantages enumerated in favour of this system an important one is that it consumes power only in proportion to the number of passengers carried. L. J. S.

175 *Measurement of Power.* (Mech. Eng. 1. pp. 473–477, 561–563, 617–620, 688–690, and 2. pp. 119–121, 190–191, 1898.) —A description of various dynamometers and methods of measuring power. EDITOR.

176. *Shaft Governor.* **T. Hall.** (Elect. World, 31, pp, 678–681, 1898.)—A consideration of the problems involved in governing. EDITOR.

177. *Oil Fuel.* (Railway World, 7. pp. 105–108, 1898.)—Descriptive of methods and apparatus. EDITOR.

178 *Thermal Efficiency of Steam Engines.* **Report of the Committee of the Institution of Civil Engineers.** (Electrician, 41. pp. 623–628, 1898).—The report is prefaced

by a note by Captain Sankey showing what it has been desired to measure and to compare. A steam plant in its simplest form consists of (1) the boiler, (2) the steam pipes, (3) the engine. Further, the plant may include (4) a condenser and air-pump, (5) an economiser, (6) a feed-heater, (7) steam jackets. The

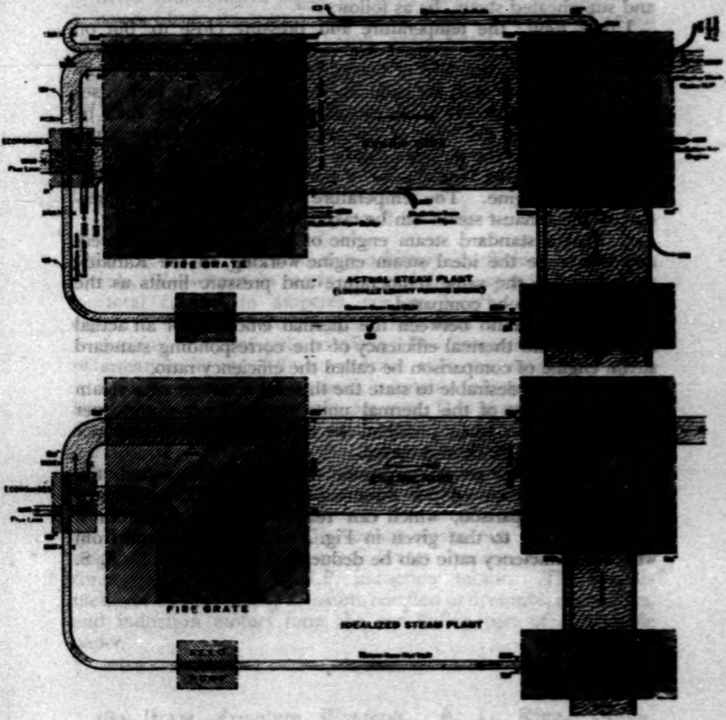

diagram represents the trial of the Louisville Leavitt Pumping Engine, and the flow of heat is stated at all points with fair accuracy. The recommendations of the Committee are:—

1. That "thermal efficiency," as applied to any heat engine, should mean the ratio between the heat utilised as work on the piston by that engine and the heat supplied to it.

2. That the heat utilised be obtained by measuring the indicator diagrams in the usual way.

3. That in the case of a steam engine, the heat supplied be calculated as the total heat of the steam entering the engine less the water-heat of the same weight of water at the temperature of the engine exhaust, both quantities being reckoned from 32° F.

4. That the temperature and pressure limits, both for saturated and superheated steam, be as follows:—

Upper limit: the temperature and pressure close to, but on the boiler side of, the engine stop-valve, except for the purpose of calculating the standard of comparison in cases when the stop-valve is purposely used for reducing the pressure. In such cases the temperature of the steam at the reduced pressure shall be substituted. In the case of saturated steam the temperature corresponding to the pressure can be taken.

Lower limit: the temperature in the exhaust-pipe close to, but outside, the engine. The temperature corresponding to the pressure of the exhaust steam can be taken.

5. That a standard steam engine of comparison be adopted, and that it be the ideal steam engine working on the Rankine cycle between the same temperature and pressure limits as the actual engine to be compared.

6. That the ratio between the thermal efficiency of an actual engine and the thermal efficiency of the corresponding standard steam engine of comparison be called the efficiency ratio.

7. That it is desirable to state the thermal economy of a steam engine in terms of the thermal units required per minute per I.H.P., and that, when possible, the thermal units required per minute per B.H.P. be also stated.

8. That, for scientific purposes, there be also stated the thermal units required per minute per H.P. by the standard engine of comparison, which can readily be obtained from a diagram similar to that given in Fig. 4 of the Report and from which the efficiency ratio can be deduced. A. S.

GENERATORS, MOTORS, AND TRANSFORMERS.

179. *Dynamo Design.* **J. K. Sumec.** (Zeitschr. Elektrotechn. Wien, 16. pp. 454–458 and 469–474, 1898.)—The methods hitherto commonly in vogue for determining the dimensions of a dynamo from its output and speed consist in using a formula (such as those proposed by Esson, Snell, Kapp, and others), connecting output with speed and length and diameter of armature. Such formulæ involve a coefficient depending on the type of machine and (more particularly in the case of alternators) the skill of the designer. The author makes a departure from this time-honoured practice, and proposes the following plan of designing a dynamo. The output of a machine may be expressed by the formula—

$$W = 10^{-8} . v \gamma B k D \pi l,$$

which does not contain any arbitrary coefficients. In this fomula, W = output in watts; v = peripheral speed in cm/sec.; γ = total current, in amperes, per cm. length of armature circumference; B = mean magnetic induction under pole-pieces; k = ratio of width of pole to pitch; D = diameter, and l = length of armature, in cms. In accordance with the conditions under which the machine is to be used, a suitable value of v is assumed; from this, and the known revs. per min., D is at once determined The values of γ and B are determined by considerations regarding heating; k will depend on the type of machine. The above formula then gives l, and thus the dimensions of the machine are completely determined. When dealing with alternators, the right-hand member of the formula has to be multiplied by half the value of Kapp's coefficient. The author works out, by the above method, the design of a 22·5-kilowatt dynamo, a 150-kilowatt three-phaser, and a 75-H.P. induction motor. The various methods of dealing with armature reaction in dynamos, alternators, and induction motors form the concluding part of a valuable paper. A. H.

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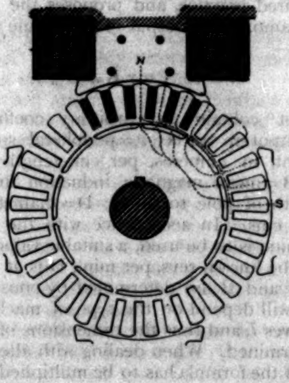
180. *Drum Armature Windings.* **A. L. Rice.** (Amer. Electn. 10. pp. 319–321, 1898.)—The author shows how to wind an armature which was designed for a multiple-circuit winding, so that it shall have a two-circuit winding. He takes as an example a four pole four-circuit armature with 48 conductors, in formed coils laid in slots. In order to convert this to a two-circuit winding, two conductors must be left out; so one end of a coil is disconnected from the commutator and insulated, and the commutator bar to which the other end of this coil is connected is short circuited on to the next commutator bar.

The author also shows how to convert a six pole six circuit winding to a two circuit winding. The paper is illustrated by diagrams. R. B. R.

181. *Reduction of Inductance of Armature Coils.* (Elect. World, 32. p. 185, 1898.)—The improvement in the construction of armature cores, illustrated in the accompanying sketch, consists in punching a set of tangential slots immediately underneath the teeth, so as to form a narrow rim in which the induction is pushed to a very high value. The inductance of the windings is thereby reduced, and sparkless running facilitated. Tests carried out on two armatures of the same size and similarly wound, but having different cores, one of the ordinary and the other of the improved type, showed a reduction in the core losses of the latter which resulted in a 2 per cent. gain in efficiency.



A. H.

182. *Windings of Multiphase Armatures.* **J. P. Stone.** (Amer. Electn. 10. pp. 367–371, 1898.)—The author states that the object of this paper is to describe a few of the most useful windings of multiphase armatures that are used in American practice.

Illustrated descriptions are given of di-phase and tri-phase non-overlapping and overlapping uni-coil and multi-coil windings.

W. G. R.

183. *Commutated Current-Wave of Compound-wound Alternator.* **D. C. Jackson.** (Amer Instit. Elect. Engin. 15. pp. 451–456, 1898.)—The author gives some interesting curves showing the commutated current-wave in the series winding of a Thomson-Houston alternator. The curves are (apart from commutation) similar to the external current curves of the machine, except in the neighbourhood of the zero point, the commutated current never reaching a zero value on account of the short-circuiting of the series coils by the brushes on the commutator. Curves are also given of the current in the separate-excitation coils; the pulsations occurring in this current may be accounted for by the rotation of the toothed armature. There does not appear to be any immediate connection between these pulsations and those in the series coils. A. H.

184. *Induction Generator Tests.* **A. F. McKissick.** (Amer. Instit. Elect. Engin. 15. pp. 457–473, 1898.)—An ordinary induction motor when driven mechanically above the speed of synchronism will act as a generator, and furnish energy to the polyphase alternator connected to it. A load of lamps may then be connected across the mains, and the induction motor will go on acting as a generator, so long as there is a synchronous motor (which may be kept running light) connected to it. Breaking the circuit or short-circuiting the mains immediately causes the "induction generator" to lose its E.M.F. The author gives a detailed account, with numerous curves, of some tests carried out with such an induction generator. The most probable use of the induction generator will be for boosting purposes. A. H.

185. *Rotary Field Motors.* **S. Hanappe.** (Écl. Électr. 16. pp. 437–450, 1898.)—This is the beginning of a series of articles on the calculation and design of polyphase induction motors. W. G. R.

186. *Regulation of Motors.* **R. E. Menges.** (Écl. Électr. 15. pp. 405–408, 1898.)—Some further remarks on motor starting and regulating switches. R. B. R.

187. *Electric Railway Motors.* **G. T. Hanchett.** (Street Rly. Journ. 14. pp. 184–186 and 517–519.)—General data and dimensions are given; also descriptions of commutators and brush-holders. EDITOR.

188. *Transformer for 150,000 volts.* **E. B. Paine** and **H. E. Gough.** (Elect. World, 32. pp. 63–65, 1898; also Journal of the Worcester Polytechnic Institute.)—A detailed account of the construction of a 20-kilowatt transformer, to transform from 50 or 100 volts to 150,000 volts at a frequency of 133. Kerosene oil was used as the insulator. The article contains some interesting photographic reproductions of discharges between terminals in air, under various conditions.

A. H.

189. *Alternating Current Transformer.* **W. F. White.** (Amer. Instit. Elect. Engin. Trans. 15. pp. 389–398, 1898.)—The author shows how wasteful the system of distribution employing isolated transformers to every consumer may be. The author found in 1892, that one of the largest alternate current stations in the United States had an income of only 3d. per kilowatt hour output at the switchboard, although the consumers were charged 10d. per unit. In other words the transmission, transformation, and distribution losses are commonly as much as 200 per cent. of the consumer's demand as shown by the meters. This also means greatly increased cost of generation. An example is given of a plant which on January 1, 1895, supplied some 16,700 16 c.p. lamps using 547 transformers with an aggregate rated capacity of 22,190 lamps. The magnetising current of the system was about 80 amperes at 1,000 volts. A system of low tension distributing mains fed by large transformers was then introduced for the central parts of the town. As a result, although the lamps connected increased to 23,643, the total capacity of the transformers used has decreased to 14,946. The income per kilowatt hour at the switchboard has increased some 74 per cent. The author estimates that 1,857 tons of coal have been saved per annum by the change. In core losses alone the reduction at working charges have been enough to pay all costs for the change of lamps, meters, and transformers, and for the laying down of the secondary net work. In spite of the increase in the number of lamps connected, the magnetising current of the system has fallen from 80 to 30 amperes. The other advantages claimed are less cost of upkeep of transformers and a more regular pressure of supply. R. W. W.

190. *Transformer Economy.* **W. E. Goldsborough.** (Elect. World, 31. pp 781–784, 1898.)—Numerous tests in the Perdue laboratories on transformers of recent design have shown the money value per annum of deviations from the specified core loss, efficiency, &c. The cost of checking the performances of the transformers would often exceed the value

of the small margin in question. Non-aging transformer iron is a commercial possibility, but it is doubtful whether it can be obtained in sufficient quantities. The difficulty seems to be to get non-aging iron which will fulfil the usual specifications for core loss. Of six different types of transformers tested, the core loss increased from 5 to 10 per cent. in three months. The rate of increase in core loss diminishes with time. The author intends to carry out a series of aging tests for one year under continuous full load conditions. As regards oil insulation for transformers, a continued heating of the oil for a long time changes it to such an extent that on being cooled, its breakdown value is often reduced by four-fifths. To prevent this, the maximum temperature of the oil should never exceed 60 or 70° C. E. H. C.-H.

191. *Improvements in Transformers.* **C. F. Guilbert.** (Écl. Électr. 16. pp. 230–236, 1898.)—This paper, which is mainly based on recent patent specifications, is of a purely descriptive nature, and deals with some recent improvements in the details of transformer construction. A. H.

192. *Design of Phase Transformer.* **A. F. McKissick.** (Amer. Electn. 10. pp. 338–339, 1898.)—An account of the design and construction of a 2½-kilowatt transformer, to be used for transforming 3-phase current at 220 volts to 2-phase current at 500 volts. A. H.

193. *Current-rushes in Transformers.* **A. Hay.** (Elect. Rev. 43. pp. 326–327, and 333–336, 1898.)—When a transformer is switched on, the first few current-waves are in general of an abnormal type, each wave consisting of a large half-wave in one direction, followed by a small half-wave in the opposite direction. The initial counter E.M.F. waves are similarly distorted. Such abnormal waves settle down gradually to the normal type of wave. The phenomenon is capable of being explained in a comparatively simple manner by taking into account the known magnetic properties of iron. In no case is there any rise of potential difference across the transformer terminals, as has been sometimes asserted. The paper contains a number of curves (obtained experimentally) which fully bear out the above theoretical deductions. AUTHOR.

POWER DISTRIBUTION, TRACTION, AND LIGHTING.

194. *Long-distance Power Transmission.* **E. J. Berg.** (Elect. World, 32. p. 206, 1898.)—The author considers the problem from a general standpoint. He advocates single-phase in preference to multiphase systems, except when dealing with very long distances, or cases in which rotary converters are to be used. The question of frequency is also discussed in general terms. A. H.

195. *Pressure Regulation in Long-distance Transmission.* **E. J. Berg.** (Amer. Instit. Elect. Engin. 15. pp. 427–449, 1898.) (See also the previous Abstract.)—In the case of very long lines having considerable inductance, there is a serious difficulty in maintaining a constant pressure at the receiving end of the line by any system of control from the generating station. For the pressure required at the generating end will depend not only on the current and power-factor of the load, but also on whether the current is a lagging or leading one, the generator pressure being very different for the two cases. Where a rotary transformer system is used, the author recommends control at the receiving end by variations of the exciting current of the transformer. The theory of this mode of control is fully worked out. In order to render the control automatic, the field of the transformer should be compound-wound. This method of control, although very satisfactory when each converter is supplied by an independent generator, is not to be recommended when several converters are operated from the same generator, or from several generators in parallel, since in that case a change in the adjustment of the series field would have to be made with a change in the generator capacity. A. H.

196. *Transmission of Electrical Energy at Les Clées-Yverdon.* **J. Laffargue.** (Ind. Élect. 7. pp. 356–362, 1898.)—This is an account of the electric installation at Les Clées-Yverdon in Switzerland. At this place the river Orbe furnishes a good fall of water which is utilised. This fall which is 45 metres high drives turbines each of 300 horse-power at a speed of 430 revolutions per minute. To the shaft of each turbine an alternator is coupled by the Zodel flexible system. The alternators are tri-phase giving a pressure of 5,200 volts at a frequency of 50 alternations per second. From this station the neighbouring towns, to a distance of 15 to 20 miles, are supplied with light and power.

The charges for power for motive purposes varies from 240 to 150 francs per horse-power per year for large motors, and from 10 to 7·5 centimes per horse-power hour for small motors according to the size. W. G. R.

197. *Alternate Current Distribution.* **H. A. Wagner.** (Elect. World, 31. pp. 740–744, 1898.)—The author states that though many alternating current stations have been started, few in the United States have been a success. The fault lies, not with the alternating current, but with the method of its application. The regulation, which should be easier than in the case of direct currents is faulty, chiefly owing to the omission of taking potential wires from the centre of distribution to the central station. The direct current three-wire system is commended and should be applied to alternating currents. The regulation cannot be performed by supplementary bus bars, but the booster method can be used. In this way the high potential mains can be dispensed with and high potential limited to the feeders. By using this system the average load, and consequent efficiency, of the transformers is raised. W. G. R.

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198. *Direct and Alternating Current Distribution.* **L. A. Ferguson.** (Elect. World, 31. pp. 779–781, and 32. pp. 7–10, 1898.)—The author in this paper, read before the National Electric Light Association, June, 1898, describes the distribution system of the Chicago Edison Company, as representing the latest developments. The continuous three-wire network is supplied from four central stations whose maximum output in 1897 was 50,730 amperes at 215 volts. The average yearly efficiency of distribution was 91·2 per cent. from the station switchboards to the customer's meter. The largest station is connected to a substation in the centre of distribution in the business district by an immense trunk line, 3,340 feet long, having a total cross sectional area of 66,000,000 circular mils, which has carried a maximum of 34,400 amperes. Outlying districts are supplied from the large stations through rotary transformers which take direct current from the bus bars at 215 volts and convert it to three-phase alternating at 160 volts, which is raised by step-up transformers to 4,500 for transmission. At the receiving end, the volts are stepped-down to 80 and then converted into direct-current at 115 volts by means of rotary transformers. A pair of 200-kw. generators is being installed for this work, each being provided with three collector-rings and designed to deliver from the same armature direct-currents and three-phase alternating currents.

In the second part of his paper the author goes on to discuss arrangements for obtaining uniformity of pressure. For long feeders he recommends a series-wound booster, connected in series with the feeder and so designed that its voltage at constant speed will be proportional to the current passing through it. The standard system used by the Edison Companies throughout America consists of lengths of japanned iron pipe containing three solid copper wires or rods insulated from each other and from the iron pipe by an asphaltum compound. The tubes are 20 feet long, the conductors projecting 3 inches beyond the ends. Tubes are connected at junction-boxes filled in with hot insulating compound. At each street-intersection is fixed a cylindrical junction-box containing three copper rings, to which the conductors are attached. This is the most complete and permanent system for direct-current distribution at 500 volts and under. Pressure charts illustrate the superiority in regulation of a direct over an alternating system. With the former, an average deviation of less than one volt should be obtained. To obtain first-class pressure-regulation with alternating distribution, the engineer must follow the lines laid down for the modern direct-current distribution system. As regards batteries, they are economically valuable in direct-current systems whose load curve has an average peak-width of not more than two hours, since the investment required for storage batteries to carry a peak of less width, is less than the investment required for steam and electrical machinery to do the same work. The superiority of direct-current for electric elevator work is emphasised and, as proof of the importance of this service, it is stated that the Edison Companies in New York, Boston, Brooklyn, and Chicago, supply for direct-connected elevators, 15,000 H.P. representing a gross income of 375,000 dollars annually. The author finds that the 3½ amperes direct-current enclosed arc lamp successfully competes with the Welsbach gas-burner. In conclusion the opinion is expressed that the successful central station company of the future will be the one combining intelligently the use of alternating and direct currents, employing direct current for the distribution systems in the thickly settled business and residential districts, and alternating current for the distribution systems in the suburbs. The energy will be generated at one or two large condensing stations which will transmit low pressure direct-current, or high pressure alternating-current, according as the substations which they supply are relatively close at hand or far away.

E. H. C.-H.

199. *Two-Wire Distribution.* **J. W. Howell.** (Amer. Instit. Elect. Engin. 15. pp. 373–378, 1898.)—The cheapness and simplicity of a two-wire system sometimes make it preferable to three wires. In distributor cables the section of the third wire should equal the outers. M. O'G.

200. *Electrically Operated Auxiliary Plant at Bristol.* **H. F. Proctor.** (Elect. Rev. 43. pp. 404–406, 1898.)—In this paper, read before the British Association, the author gives a brief description of the Bristol electric lighting system and the detailed results of tests made to determine the comparative performance of steam and electricity in driving pumps, &c. The results are expressed in terms of steam used per B.H.P.

hour, on the basis of 32 lbs. steam per B.T.U., and are summarised below:—

	Steam.		Electricity.	
Feed pumps...............	98	lbs.	43·2	lbs.
Donkey pumps	544	„	95·5	„
Circulating pumps	90·6	„	48·26	„
Centrifugal separators...	220	„	37·6	„

A. H. A.

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201. *Electrical Transmission of Energy.* **A. Siemens.** (Elect. Rev. 43. pp. 406–408, 1898.)—In this paper, read before the British Association, the author discusses the subject of electrical transmission in general, and describes the installation at the works of Siemens Bros. & Co., Charlton. The load factor during 1897 was 0·18; special tests in May and June, 1898, showed the day-load factor to be 0·36, with a consumption of 5·13 lbs. coal per B.T.U., while the night-load factor was 0·10, with 10·42 lbs. coal per B.T.U. The average coal consumption was 6·55 lbs. per B.T.U. The cost, inclusive of all charges, was 1·287d. per B.T.U. at the switchboard, and 2d. per B.T.U. given out by the motors. The expenses were divided as follows:—

Standing charges..................	49·1	per cent.
Fuel	26·8	„
Labour..................................	12·0	„
Stores	6·0	„
Repairs	6·1	„

Particulars are also given of two installations for long-distance transmission on the three-phase system at 10,000 volts pressure.

A. H. A.

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202. *Electric Motive Power in Small Industries.* **A. H. Gibbings.** (Elect. Rev. 43. pp. 408–410, 1898.)—In this paper, read before the British Association, the author summarises the uses to which small electromotors may be applied, and discusses the reasons why they are not more generally adopted; he advocates the hiring-out of motors at a rental of about 10 per cent. upon their cost, and gives data showing the results of this system in two years' working at Bradford. A list of direct current central stations, with the number and H.P. of the motors supplied by them, is added. A. H. A.

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203. *Electric Light and Power on the Midland Railway.* **W. E. Langdon.** (Electrician, 41. pp. 754–757, 1898.)—A brief account is given of the electrical installations of the Midland Railway, with tables showing the cost of fuel and labour and

other particulars of the various generating stations. The average running cost in 1897 was 2·511d. per unit, inclusive of all repairs and renewals, but exclusive of interest and taxes. The Derby installation is treated more fully.

Experiments have been made to ascertain the power absorbed in driving shafting and small machine tools, of which the results are tabulated in detail; an extract from the tables is given below. The author concludes that a marked economy can be effected by driving direct with electromotors.

Power Absorbed in Driving Main Shaft, Counter Shafting, Belting, and Lathes. Main Shaft 98 ft. 4 in. long, 2 in. diameter, having Twelve Bearings each 4⅜ in. long, and ordinarily driving nineteen Belts.

Machine.	Work done, metal cut away.					Power absorbed.					
Description.	Weight.		Traverse.	Time occupied.	Total revs. of metal cut per min.	Main shaft.	Counter shafting.	Machine.	Cut.	Total.	Per oz. metal cut per min.
	Total cut.	Cut per minute.									
	oz.	oz.	in.	m. s.	revs.	watts	watts	watts	watts	watts	watts
9½ in. screw-cutting lathe	2½	1·1	3⅛	2 20	250	272	55	54	164	545	509
6 in. lathe..........	2¼	1·1	3	2 0	394	272	82	55	245	654	584
5 in. lathe..........	2¼	1·0	3	2 20	393	272	55	82	136	545	567
6 in. saw	1½	0·5	..	2 30	1,827	272	55	27	136	490	980
¼ in drill	¼	0·08	..	3 0	310	272	82	..	27	381	4,950
Grindstone	..	..	..	2 30	100	272	..	82	191	545	..
Buff	..	..	..	2 30	1,300	272	55	27	82	436	..
10 in. screw-cutting lathe	2¼	1·0	3	2 20	190	272	137	27	54	490	507
1 to 2 in. drill	4¼	1·7	..	2 30	156	272	88	76	272	708	416
6 in. screw-cutting lathe	2	1·7	3	1 10	272	272	55	27	191	545	317
6 in. lathe..........	2¾	2·4	3	1 10	380	272	109	55	109	545	230
6 in. lathe..........	2	2·4	3	0 50	362	272	137	27	163	599	246
5½ in. screw-cutting lathe	2½	1·0	3	2 30	300	272	82	17	65	436	436
5 in. lathe..........	2½	1·0	3	2 25	362	272	82	55	136	545	524
¼ to 1½ in. drill	¼	0·1	..	2 15	220	272	88	76	54	490	4,454

A. H. A.

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204. *Central Station at St. Louis.* **G. A. Damon.** (Elect. World, 32. pp. 36–38, 1898.)—This is a description of the plant of the Imperial Electric Light, Heat and Power Company, of St. Louis, Mo. A point of special interest is the method of connecting generators to prime movers. The engines are directly connected to four 500-kilowatt generators and two 50-kilowatt boosters by means of the "Arnold System." The idea of the system is to improve upon the usual direct connected unit principle by mounting each generator in such a manner that it

can be operated by more than one engine. Three engines are to be used on one shaft, the capacity of the centre engine being 1,500 horse-power, and double that of either end engine. The central engine has a sufficient capacity to operate two of the generators, while either end engine can drive one generator.

Each generator armature is mounted on a hollow shaft or quill, which is carried on independent bearings. The booster armature is attached to the solid shaft. This shaft is made of forged steel and is extended at both ends through the hollow generator-quills, but without touching them, so that it is supported in its own bearings between the two quills. By means of this shaft any engine can reach the generators not contiguous to it, but under all normal operating conditions this shaft does not turn, so that this system of connecting involves no more friction and requires no more lubrication than the ordinary arrangement. The coupling on the end of the shaft permits of three combinations: The engine may be directly connected with the quill of the adjacent generator, allowing the interior shaft to remain idle, or the solid shaft may be attached to either the engine flange or to the generator-quill. The clutch is of the magnetic type.

W. G. R.

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205. *Missouri-Edison Electric Company of St. Louis.* **H. A. Wagner.** (Elect. Engin. N.Y. 25. pp. 629–648, 1898.)—This is a very complete and illustrated description of the works of the Electric Company of St. Louis. It is useful in giving the details of the management and arrangement of high tension alternating current machinery on a large scale, the aggregate horse-power being 11,000. W. G. R.

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206. *Cork Electric Tramways.* **B. Griffin.** (Elect. Engin. 22. pp. 200–203, 1898.)—There are 11 miles of track, mostly single line, of which 1¾ miles, being beyond the city, are laid with sleepers. The steepest grade is 1 in 14, and the sharpest curve is 27 ft. radius. American 6½ in. girder rails are used, 83 lbs. to the yard. The plant comprises three McIntosh & Seymour compound condensing engines direct coupled to 220-kw. generators, running 150 revolutions per minute; three Babcock and Wilcox boilers evaporating 8,000 lbs. of water per hour; also 256 tudor cells, capable of discharging 110 amperes for 7 hours. The chimney, which is 130 ft. high and 7 ft. 6 in. in diameter, is built of riveted steel plates, 4 ft. 6 in. high, 7/16 in. thick at bottom, and ¼ in. thick at top. It is claimed that the saving in cost of the steel shaft over a brick stack was about 25 per cent., while the time in erection was reduced.

E. H. C.-H.

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207. *Electric Traction on the Erie Railroad.* (Elect. World, 32. pp. 256–257, 1898.)—The branch of this railroad running from Tonawanda to Lockport, N.Y., and formerly operated by steam locomotives, has recently been provided with electric equipment. Passenger traffic is carried on trolley cars and freight service by electric locomotives. The cars also run over various electric railway systems in the neighbourhood. Power is obtained from the Niagara Falls Power Company at 10,500 volts, carried in 4/0 bare copper wires on cedar poles to a rotary-converter sub-station. Special high-tension switches are used, the blades of which are pulled down by means of a hooked stick. Two 36-ton locomotives are used, each equipped with a K 24 controller and 4 G.E.-55 motors, each rated at 160 H.P. The draw-bar pull at full speed is 3,400 lbs., handling a 340 ton train at 15 miles per hr. The trolleys of the locomotives are pneumatically controlled. The passenger cars are each equipped with B-8 controllers and 4 G.E.-57 motors, each rated at 52 H.P., with electric brakes on each axle, calculated to give a service at an average speed of 45 to 50 miles per hr. E. H. C.-H.

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208. *Electric Railways of Springfield and Holyoke, Mass.* (Street Rly. Journ. 14. pp. 415–423, 1898.)—The power station for the Springfield system contains two 1,200 H.P. cross-compound Hamilton-Corliss engines, and one 600 H.P. tandem-compound McIntosh & Seymour engine, each of the former being direct connected to an 800-kw. G.E. generator, and the latter belted to two 200-kw. Westinghouse generators. The Holyoke plant comprises three Green engines connected to 300-kw. G.E. generators. No chimney-stack is employed, but mechanical draught is provided by a duplicate set of 8 ft. fans. The Mount Tom mountain-line, which rises 700 ft. in 4,900 ft., with a maximum grade of 21½ per cent., is worked by two cars connected by a 1¼ in. cable over an 8 ft. return sheave at the upper end of the line. There are no winding engines to drive the cable, but each car is equipped with two G.E. 1,000 motors, the cable being used only to balance the dead weight in the cars. E. H. C.-H.

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209. *The Boston Subway.* (Street Rly. Journ. 14. pp. 493–500, 1898.)—In December, 1894, the Boston Transit Commissioners found that 79,944 passengers got off and 96,590 passengers got on cars on the route to the proposed subway, and at one point 215 north-bound cars and 191 south-bound cars passed in one hour. The subway was accordingly designed to accommodate with ease this amount of traffic. Plans, sections, and illustrations of the subway and stations are given with particulars of method and cost of construction. To avoid stopping traffic, most of the

subway was built in slices, the ordinary street traffic being bridged over the trench thus formed. The right to use the subway has been leased by the city for 20 years to the West End Street Railway Co. for an annual payment equal to 4⅞ per cent. of the net cost of the subway. E. H. C.-H.

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210. *Electric Traction at Havre.* (Écl. Électr. 14. pp. 564–566, 1898.)—The tramway connecting the town of Havre with the Sainte-Marie Hill commenced working last September, and although only 750 metres long, offered special difficulties owing to the narrowness of the streets and to the steep gradients, this being one of the steepest lines in Europe. It was carried out by the Thomson-Houston Co., who supplied special cars, each carrying two G.E. 1,200-motors, capable together of developing 100 H.P.

Three special brakes are employed, any of which are alone sufficient to stop the car. They consist of: (1) a magnetic brake; (2) a brake consisting of four friction-blocks operated by an endless screw; (3) a brake consisting of sliding shoes also worked by an endless screw and powerful enough to raise the car on to the shoes. Besides these, two devices are employed, operated from either end of the car, to avoid any chance of running downhill in the event of the current being broken. The cars are fitted with sandboxes in order to prevent skidding in coming downhill. The cars ascend and descend at the rates of 12 and 8·5 km. per hour respectively. The current supplied to the motors varies from 90 to 140 amperes, according to the gradient. L. J. S.

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211. *Three-phase Tramway at Evian-les-Bains.* (Electrician, 41. p. 580, 1898.)—Current is transmitted at 5,200 volts at a frequency of 50 from an old three-phase station eight miles away, and is converted by a 30-kw. stationary transformer to 200 volts. This transformer feeds a 6-H.P. motor for an hotel lift as well as the trolley line. The one car on the line is fitted with one three-phase motor rated at 15 H.P. but capable of 30 H.P. for a short time. The motor, whose speed is 750 R.P.M., drives a countershaft through spur gearing; the countershaft being connected to the axles by chain gearing. This arrangement is claimed to give sufficient adhesion for the heavy gradients on the line, the worst of which is 10·2 per cent. The motor is in circuit during ascent and descent, in the latter case running as a generator slightly faster than the speed of synchronism. If one of the trollies gets off the wire the motor continues to run as a single-phase motor. The car weighs 3·8 tons, holds 14 passengers, and makes 60 double journeys a day at a speed of 6½ miles per hour. E. H. C.-H.

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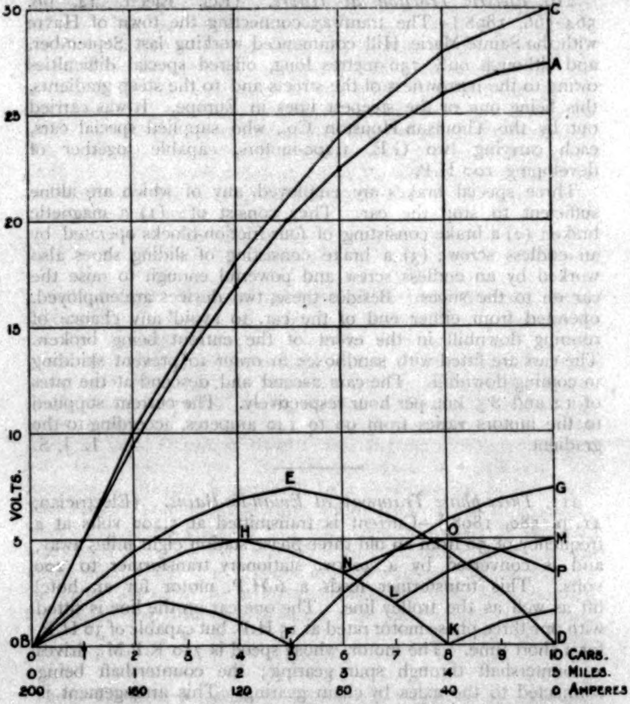
212. *Electric Tramways.* **P. Cardew** and **A. P. Trotter.** (Instit. Elect. Engin. Journ. 135. pp. 456–460, 1898.)—"A neat graphical method of determining the fall of potential in the return with uniform distribution of current, and the proper points of application of return feeders," is given in the form of a note by A. P. Trotter. Assume 10 cars each taking 20 amps., on a line 5 miles long, with turn outs, the resistance of the bonded rails being 1/20 ohm per mile. Then when the cars are evenly distributed, the series is as follows :—



Cars	1	2	3	4	5	6	7	8	9	10	Works.
Volts	0	½	1½	3	5	7½	10½	14	18	22½	27½.

The line A B shows the fall of volts in this case, and the line C B when the cars are in pairs a mile apart. The difference in drop in the two cases is negligible.

To reduce this fall of volts, the rails may be tapped by a return feeder connected with a negative booster which "sucks the current back," and thus the rails at the feeder end may be brought to zero potential or less. The problem is (*a*) to reduce the volts below a fixed maximum; (*b*) to use as little copper as possible; and (*c*) to use as little energy as possible. Disregarding the last two conditions, the volts at the far end of the line might be brought to zero by a single feeder to that point. To draw the curve of distribution, cut out a piece of card to the shape of the curve of volts A B, and fitting the vertical axis to the ordinate 5, place it so that it passes through the point D. Turn the card over, and complete the curve through B in the same way. The maximum volts, at the point E, are 7½. Similarly, we can by the template draw B F G showing distribution with one feeder to the middle point of the line. Again, given the drop allowable, we can draw B H K by the template. But it is not necessary to reduce the drop so much on the last part of line, and we therefore find, by use of the template, that if we let the drop rise to the maximum at the end of the line, the feeder must tap at L. This is the best arrangement possible with a single return feeder.

A "Note on Electric Tramways," prepared by P. Cardew in 1894, is then given. If we assume n auxiliary conductors, all of equal resistance, connected to the main conductor at equal distances throughout its length, and one from the extreme end of the main conductor of twice the resistance of the others, a resistance equal to this last being interposed between the generator and the near end of the main conductor, then with a uniform distribution of current all the points of junction will be at the same potential, and the extreme difference of potential between any points of the main conductor will be reduced to $\frac{1}{4(n+1)^2}$ of what it would be without these auxiliary conductors or feeders. Instead of adjusting the resistances of all feeders to equality, varying E.M.F.'s may be introduced into each feeder, proportionate to its resistance.

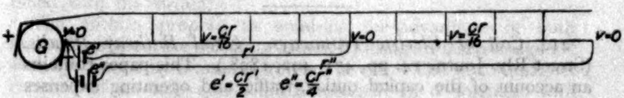


FIG. 4.

NOTE.—*V* indicates potential with regard to earth; *e'* and *e''* auxiliary E.M.F.'s.

The disposition shown in Fig. 4 would be defective at times unless the E.M.F.'s were continually adjusted to the variations of load. Automatic adjustment may be obtained by the following arrangement: Divide the tramway into several sections according to its length, and the amount of traffic, gradients, &c.

Provide for each section two insulated feeders, one for the line and one for the return. Let the currents in these feeders pass through a motor generator at the generating station, the field magnets of which are excited by the current to line alone, while the armature is wound with two circuits—one for each current, so as to oppose each other—the circuit through which the current to line passes being made slightly the more powerful. The motor generator will then revolve as urged by the line current, and will generate an auxiliary E.M.F. for the return current.

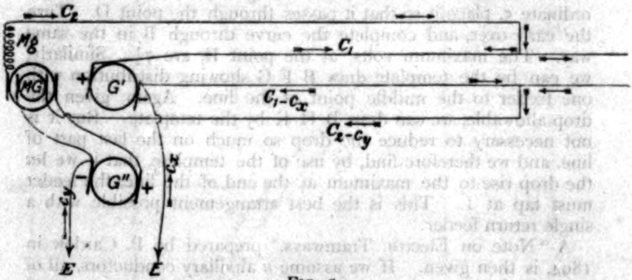


FIG. 5.

G' = generator ; G'' = auxiliary generator ; MG = motor generator ; Mg = magnetising coils of motor generator.

This system may be expensive, but can be adapted to lessen the drop at any part of an existing tramway. Such an arrangement with one pair of feeders is sketched in Fig. 5.

E. H. C.-H.

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213. *Electric Traction.* **P. Lauriol.** (Écl. Électr. 16. pp. 192–202, and 203–208, 1898.)—Notes on electric traction in about 30 European towns. EDITOR.

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214. *Cost of Electric Tramways. Street Railway Results.* (Street Rly. Journ. 14. pp. 471–492, 1898.)—This paper contains an account of the capital outlay, traffic, and operating expenses of 39 street railways in Boston City and 75 suburbs. After illustrating and describing the various systems, the paper concludes with a *résumé* of investments and operating statistics for the nine groups into which it divides the systems. Emphasis is laid on the fact, that owing to the unusual care of the Railroad Commissioners in Massachusetts, these figures are among the truest available measures of value of both construction, costs, and earning power which can be found for street railways in America.

E. H. C.-H.

215. *Jenny Conduit System.* (Street Rly. Journ. 14. p. 563, 1898.)—This system, for which small first cost, thorough insulation, and simplicity are claimed, was invented some years ago, but has only recently been put into use. The conductor is a flat-headed rail, supported from the fish-plates by upwardly inclined arms with bell-shape ends, which fit over petticoated insulators. Contact is made by a brush supported by a bar passing through the slot, and held down by its own weight. Construction at crossings is claimed to be especially simple.

E. H. C.-H.

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216. *Moreau Closed Conduit System.* (Électricien, 15. pp. 296–297, 1898.)—The Moreau distributor consists of a device in which the motion of the front wheel of the car causes a rotating contact maker to advance by one tooth by the action of a pawl, this connects the rail or contact under the car to the feeder. The second wheel causes the contact maker to advance by another tooth, and the local circuit is then broken. This process is repeated on the passage of the next car. This system, which is very strongly constructed, appears to be capable of reliable working. The author criticises the large number of distributing boxes which the system requires. To avoid the large number of sections on curves of small radius it would be necessary to use bogie cars. This remark would apply to all systems belonging to this class.

L. J. S.

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217. *Thompson-Walker Surface Contact System.* **S. P. Thompson** and **M. Walker.** (Electrician, 41. pp. 751–754, 1898.)—The authors give an outline description of the more important surface contact systems which have been brought forward since 1881, and point out that, while those which depend upon the action of a magnet carried on the car are, in general, free from risk of operation at the wrong time, they are not so positive in action as those in which the electromagnet is combined with the switch.

The authors propose to combine the advantages of both methods, without the defects of either, by using an electromagnetic switch actuated by a mass of iron on the car. The electromagnet consists of an iron core sliding vertically in a solenoid, with expanded iron heads so shaped that the core has no tendency to rise when a current is flowing in the solenoid, unless there is a mass of iron immediately above the contact stud. The apparatus is placed in a cast-iron box filled with oil; when the iron core rises, the displacement of the oil permits a float to fall and close a mercury switch, making the contact stud "alive." When the skate which is carried on the car breaks contact with the stud, the iron core falls, raising the float and opening the mercury switch; at the same time a mercury contact is made, by which the stud is earthed, so that if by any chance the switch should remain closed, a fuse would be blown and the apparatus cut out of action. The paper is illustrated with figures and diagrams of connections. A. H. A.

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218. *Corrosion of Pipes by Return Currents of Electric Tramways.* **J. A. Fleming.** (Electrician, 41. pp. 689–692, 1898.)—The author discusses the Board of Trade Regulation No. 6 (ii.), which limits the potential difference between the rails and buried pipes, and describes experiments made to determine whether corrosive action can occur when this regulation is obeyed. The specific resistance of moist clay was found to be about 1,566 ohms; this greatly increased as the moisture evaporated, showing that the conduction was in great part electrolytic. Tests made on a small scale showed that electrolytic corrosion took place with a potential difference of one volt or less, iron being removed at a far greater rate than corresponded with theory; these experiments were repeated on a practical scale over a period of six months, with similar results. In the case of an electric tramway, part of the return current must leave the rail at points of high potential and flow through the earth, &c., to points of lower potential; the effect of this on pipes depends on their position with regard to the lines of current flow. A model was made to represent an actual tramway system, with pipes running in various directions, by means of which a survey could be made of the electrical conditions set up, and information gained as to the probable locality of corrosive effects. The author concludes with a summary of the facts bearing on the subject, and the conditions under which corrosion may be expected to take place. A. H. A.

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219. *Earth Returns, and Electrolysis.* **A. B. Herrick.** (Eng. Mag. pp. 451–457, 1898.)—The action of the ground-current on various kinds of pipes is discussed, and remedies are suggested. Cast-iron pipes are not attacked so rapidly as wrought-iron; lead surfaces and brass nipples suffer most. Clay is the best soil for insulating purposes; loam charged with salt water the worst. If saturated with coal- or sewer-gas, the resistance of the soil is greatly reduced. Current leaving the rail increases the capillary activity of the soil, and draws water towards the rail. The rail positive to the soil is always moist. E. H. C.-H.

TELEGRAPHY AND TELEPHONY.

220. *Hertz Telegraphy.* **M. Tietz.** (Electrician, 41. pp. 658–660, 1898, and Elektrotechn. Zeitschr. Aug. 18, 1898.)—Quantitative experiments are described, using a Klemenčič thermo-element or a Ruben's bolometer, to determine the intensity of received waves. When the radiator is a point, the inverse-square law holds; when it is a line, the intensity varies directly as the distance. Hence the advantage of adding a wire to the sending and receiving apparatus. Curves are drawn indicating that intensity, in practice, varies according to a law intermediate to these two cases. Results obtained with different detectors (spark-gap, coherer, bolometer) are not always in agreement. The quantitative change of resistance of a coherer does not appear to bear any definite relation to the constants of the emitter, and it seems to be independent of the length of the "collecting wire." Syntony is therefore necessarily imperfect so long as a coherer is used as the receiver. The thermo-element and the dynamo-bolometer have greater possibilities than the coherer as regards syntony.

The author recommends a radiator formed by putting short, bent pieces of wire into a block of paraffin wax, with a short spark-gap between each pair of wires. The whole is immersed in oil in an ebonite box. This radiator is said to be 20 times more effective than the Marconi-Righi apparatus. As a receiver, the bolometer was more sensitive than the thermo-element in the ratio of 13 to 5. A receiver is suggested consisting of thermo-elements of alternate large and small junctions. The remainder of the original article is devoted to the proposition to use a selenium cell as a sensitive relay. (With regard to the history of the "collecting" wire, reference should be made to the Electrician, 39. p. 832, 1897. For experiments on the selenium cell as a relay, see Proceed. Physical Soc. vol. ii. pp. 96–98, 1891.) R. A.

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221. *Syntonised Vibrators for Wireless Telegraphy.* (Elect. Rev. 43. pp. 260–263, 1898.)—This is a description of improvements devised by Lodge in apparatus for "sending" and "receiving"; they are the outcome of examining the theoretical conditions of syntony. Diagrams are given of "discharge gaps" associated with capacity areas and self-inductance coils, designed to prolong the series of electric oscillations in the radiator, and to give them definite pitch. The connections are in most of these cases arranged so that the charges of electricity, after being communicated to the radiator system, oscillate free from the disturbances of supply wires. Methods are also described for charging the capacity areas with an "impulsive rush." The

capacity areas may take the form of a roof of a shed or other building, which may be used to contain the other instruments. Particulars are given of the self-inductive coils, and the switches to be used for adjusting the conditions of syntony. This article appears to have been developed from Patent Specifications, but references are omitted. (See Proceed. Physical Soc. vol. xvi. pt. 1. pp. 58–61, 1898.) R. A.

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222. *Wireless Telegraphy.* **Schluckebier.** (Archiv Post Tele. 7. pp. 208–214 and 240–246, 1898.)—An interesting *résumé* of the history of the subject, both as regards the utilisation of earth-currents and the Marconi methods. The experiments of the British and German Post Offices and of the Italian Marine are described, as well as those of Prof. Slàby, and the application of Marconi telegraphy to Hughes' instruments by Dr. Strecker, and Slàby's observation that Marconi's method, applied parallel to the ordinary telegraph wire, enables an independent set of messages to be sent along with the ordinary telegraph signals to distances much greater than those for which wireless telegraphy is practicable across free space. A. D.

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223. *New Telephone System in Paris.* **M. O'Gorman.** (Lightning, 14. pp. 196–197, 1898.)—The multiple boards are with jacks in parallel without test keys and with indicators automatically reset. When a jack is plugged, the corresponding call-index disappears and is insulated from the speaking line. A new departure is made by the use of a visible indicator on each outgoing jack repeated on every operators section as long as that jack is in use; it automatically disappears when that line is free. This saves much time. AUTHOR.

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224. *Telephone Systems.* **C. Raphael.** (Electrician, 41. pp. 85–88, and 494–498, 1898.)—Descriptive of the systems in Great Britain. EDITOR.

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225. *Telephone Work.* **A. E. Dobbs.** (Elect. Engin. N.Y. 25. pp. 605–607, 657–658, 679–680, 711–712, and 26. pp. 12–13, 31–32, 108–110, and 127–128, 1898.)—Practical notes. EDITOR.